REPORT

OF THE

Department of Scientific and Industrial Research

FOR THE YEAR ENDED

31 MARCH 1961

Presented to the House of Representatives by Leave

COMMONWEALTH MYCOLOGICAL INSTITUTE
8 SEP 1961

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MINISTER'S STATEMENT

THE reports of the Department of Scientific and Industrial Research and of the Council of Scientific and Industrial Research for the year ended 31 March 1961 are presented herewith.

In addition to fulfilling its special functions under the Scientific and Industrial Research Act the Council has given consideration to a number of important matters of scientific policy. I should like to record my thanks to members of the Council and of its specialist committees for the time and thought they have devoted to this work. In particular I wish to thank Mr J. Andrew and Dr F. J. Llewellyn who have completed their terms of office and to welcome Professor S. R. Siemon and Dr A. Stewart who have replaced them on the Council.

Last year it was announced that a Committee of the Council had been set up to coordinate wool research being supported by the New Zealand Wool Board and the Department of Scientific and Industrial Research and to advise on the future organisation and scope of wool research. It is with great satisfaction that I am able to state that, as a result of the work of this committee, the Government has agreed to the establishment of an independent research association – the Wool Research Organisation of New Zealand (Inc.) financed jointly by the Wool Board and the D.S.I.R. with initial contributions of £50,000 a year from each. It is hardly necessary to stress the significance of this progressive move in view of the vital importance of wool in the national economy.

During the year, the new laboratories of the Meat Industry Research Institute of New Zealand (Inc.) at Hamilton were officially opened. It is gratifying to know that this Institute is now permanently housed in buildings which will enable its development in keeping with the importance of the meat export industry which it serves.

The present standard of production of our agricultural industries could not have been achieved without the work of New Zealand scientists nor can it be maintained or raised without continuing research and the application of its results. If our resources of man-power and materials are to be effectively employed there is no less need for the application of science both in manufacturing industry and in the Government's own undertakings.

It was with these considerations in mind and the need to make the best use of the limited resources of scientific staff and finance that the Government has decided to set up a Committee of Inquiry into the organisation of research in New Zealand. While the precise form of the Committee and its terms of reference remain to be finalised it is hoped that it will indicate ways in which scientific research sponsored directly by the Government should be organised and financed to remedy immediate deficiencies and to ensure that the long-term pattern of development is in the best interests of the nation.

I should like to take this opportunity of thanking the staff of the Department and of expressing appreciation of their work, the wide scope and value of which is indicated in the accompanying reports.

BLAIR TENNENT,
Minister in Charge of the Department of
Scientific and Industrial Research.

REPORT OF THE COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

The Hon. W. B. TENNENT, Minister in Charge of the Department of Scientific and Industrial Research.

WE have the honour to submit herewith the report of the Council of Scientific and Industrial Research for the year ended 31 March 1961.

The Council consists of a chairman and not more than eight other members, not more than two of whom may be "officers employed in the service of the Government". The membership of the Council at 31 March 1961 was:

M. M. Burns, C.B.E., M.SC.(N.Z.), PH.D.(ABERDEEN), F.N.Z.I.C., (Chairman).
I. J. Cunningham, C.B.E., D.SC.(N.Z.), PH.D.(ABERDEEN), B.V.SC.
A. F. Downer, C.B.E., M.I.C.E., M.N.Z.I.E.
C. Hilgendorf, M.A.
K. E. Seal, M.SC.(LONDON), A.N.Z.I.C., F.G.S.
S. R. Siemon, M.APP.SC., B.SC.(Q'LD.), M.I.CHEM.E., A.A.C.I., F.N.Z.I.C., M.N.Z.I.E.
R. Slade.
A. Stewart, D.PHIL.(OXON.), M.AGR.SC.
A. H. Ward, O.B.E., A.R.A.N.Z.
W. M. Hamilton, M.AGR.SC., D.SC., N.D.H.(N.Z.) (Secretary).

Dr F. J. Llewellyn and Mr J. Andrew retired on rotation on 31 December 1960 and the vacancies were filled by the appointment of Professor S. R. Siemon and Dr A. Stewart for a period of four years from 1 January 1961.

Five meetings of the Council were held during the year, and its various committees met regularly. The Council wishes to take this opportunity of expressing its appreciation of the valuable work done by members of its committees.

ORGANISATION OF RESEARCH

In our last report Council recommended "the establishment of a National Research Organisation as an independent organisation responsible for the main research functions of Government. Such an organisation should be a body corporate employing its own staff and should submit an annual report to Parliament and receive an annual appropriation of funds".

Council is still of this opinion and welcomes Government's stated intention of establishing a committee of inquiry to investigate and report on the organisation of research in New Zealand.

Council believes that a committee of three members would be adequate, of whom one should be a New Zealander who need not necessarily be a scientist, but should have a broad appreciation of the New Zealand economy and should not be closely associated with any of the existing organisations conducting scientific work in New Zealand. The other two members should be eminent overseas scientists, at least one of whom should have had experience in the organisation and control of research.

The committee should be given broad terms of reference, with authority to investigate all aspects of research organisation, in order to

ensure that the long-term pattern of development is in the best interests of New Zealand. The committee should also include within the broad scope of its reference such matters as the nature and scope of scientific research required for New Zealand's future progress, the scale of activity desirable in our developing economy, the relationship between scientific research directly sponsored by Government and that conducted by the New Zealand universities and other institutions, the terms and conditions of employment of scientists, and the means of dissemination and application of the results of research.

Having announced its intention to set up such a committee of inquiry, we feel it is a matter of some urgency that Government should proceed without delay since other important matters may be deferred pending a resolution of the major issues involved.

FINANCE FOR RESEARCH

D.S.I.R. expenditure since 1949–50 is shown in the summary below, together with a column showing expenditure as a percentage of the gross national product (national income).

Year	Staff at 1 April		Gross Expenditure		Gross National Product	D.S.I.R. Expenditure as Percentage of National Product
	Professional	Total	Actual	At 1949 Values		
			£(000)	£(000)	£(m.)	
1949–50 ..	363	939	959	950	553	0·173
1950–51 ..	390	981	962	904	697	0·138
1951–52 ..	386	997	1,096	925	723	0·152
1952–53 ..	402	1,012	1,010	792	758	0·133
1953–54 ..	374	931	1,089	817	838	0·129
1954–55 ..	374	937	1,149	824	930	0·124
1955–56 ..	372	928	1,213	850	982	0·123
1956–57 ..	366	946	1,404	949	1,029	0·137
1957–58 ..	369	972	1,535	1,018	1,085	0·142
1958–59 ..	383	1,023	1,658	1,050	1,141	0·146
1959–60 ..	390	1,067	1,812	1,110	1,233	0·147
1960–61 ..	401	1,121	2,030	1,230	*	*

*Figures not available.

As we have emphasised in previous reports New Zealand is lagging seriously behind her overseas competitors in the application of science and the scale of research necessary to maintain her competitive position. In 1959–60 New Zealand spent in total about £3·98 million on scientific work or 0·32 per cent of the gross national product. This figure may be compared with 2·3 per cent in Britain and 2·7 per cent in the United States in 1957–58.

Between 1956 and 1959 Britain doubled the amount spent on civilian research. By comparison the expenditure of D.S.I.R. in New Zealand did not quite double between 1949–50 (expenditure £959,000) and 1959–60 (expenditure £1,812,000). This rate of increase of expenditure has barely kept pace with inflation. Total expenditure other than salaries was £489,900 in 1949–50 and this increased to £795,389 in 1959–60, a sum equal in purchasing power to £487,000 at 1949 prices. In other words, during a period of rapid growth in which total population has increased by over 20 per cent the funds available for research in D.S.I.R. have remained static.

In our report last year we recommended that the "full implementation of the present programme of work of the Department will require an increase of 40–50 staff per year" for the next five years. This recommendation was made only after visiting all branches of D.S.I.R. and making a detailed survey of programmes of work, facilities available, etc. No action has been taken on our major recommendations.

Your Council views this position with grave concern. We would once again emphasise the need for more support for scientific investigation in New Zealand if we are to sustain or improve the standard of living of a population projected to reach three million in little over 10 years and four million in under 30 years.

RESEARCH GRANTS TO UNIVERSITIES

Almost since its inception your Council has made grants to support research in the universities. In recent years these grants have amounted to approximately £30,000 annually. Last year Government increased the research funds available to the universities from £25,000 in 1950–60 to £65,000 last year and £100,000 per annum for the remainder of the quinquennium. At the same time Government asked Council to review the policy of research grants by Government Departments to the universities and the machinery for examining the allocation of finance for research in order to ensure coordination of research programmes.

We have examined the matter in detail and have had discussions with the University Research Committee and the chairman of the new University Grants Committee. The general basis of this discussion has been that a certain minimal level of research is essential to good university teaching and this basic level should be a charge against University funds; it should not be dependent on any outside body like D.S.I.R. to provide funds for this purpose.

It is therefore proposed that the type of research grant made to the universities in the past by D.S.I.R. should terminate at the end of the present financial year. D.S.I.R. should continue to foster research in the universities but in future should change over to: (a) sponsoring and providing funds for research units in universities in fields of study deemed essential in the national interest and in which an outstanding man is stationed in the university; and/or (b) entering into research contracts with universities to undertake specific research projects which D.S.I.R. wants done.

In order to ensure coordination in research policy and projects it is recommended that the Secretary, D.S.I.R. should remain a member of the University Research Committee, and that the chairman of the University Research Committee should be invited to attend meetings of the Council S.I.R. when matters concerning grants from D.S.I.R. for research projects in the university are under review.

SALARIES FOR SCIENISTS

Council has been pleased to see the adoption by Government of improved salary scales for scientists. These bring salaries of scientists in the Public Service into reasonable accord with the new salary scales adopted in the universities in New Zealand. These new scales will help to retain outstanding men in New Zealand and assist in attracting promising local graduates. The new rates however still leave a large gap between local rates and those paid in other Commonwealth countries.

WOOL RESEARCH

Council is very gratified that Government has approved its recommendation for the establishment of a new Wool Research Organisation as an incorporated research association with an annual income of £100,000 per annum, half contributed by the New Zealand Wool Board and half by Government. The main object of the new organisation is to promote and conduct research in connection with the physical, chemical, and biological properties of wool, and the handling, storage, transport, and marketing of wool. The new organisation will also make grants for research in connection with the breeding, feeding, and management of sheep in so far as these affect primarily the quantity and grade of wool produced.

The new organisation has decided to establish its laboratories on the campus of Canterbury Agricultural College at Lincoln and is at present advertising for a Director.

Council welcomes this move, which it believes is essential to maintain the competitive position of New Zealand crossbred wool in the world's markets. Most of the wool research being undertaken in Australia and elsewhere overseas is concerned with the properties of fine wools, and New Zealand must undertake similar investigations regarding the properties of crossbred wools which form the bulk of New Zealand production.

MEAT RESEARCH

During the year the new buildings for the Meat Research Institute were completed and the staff moved into the very fine and excellently equipped laboratories.

Council is particularly pleased that the programme of meat research initiated in the Department and continued since the formation of the Institute in temporary accommodation within departmental laboratories has provided a nucleus of highly qualified staff and a sound basis for continued research in both fundamental and applied aspects relative to the nationally important meat industry.

ANTARCTIC RESEARCH

During the year Council gave special consideration to New Zealand's continued participation in scientific activities in Antarctica. Council reviewed these activities in detail and feels that the scientific work being undertaken is of high quality and is scientifically well worth while. The results of scientific work in Antarctica are being published promptly and have brought credit to D.S.I.R. and to New Zealand as a whole. However, because of the physical conditions in Antarctica and the logistic problems involved, scientific work in this area is necessarily more expensive to maintain than similar work conducted in New Zealand, and the continuance of work in Antarctica makes a heavy drain on available finance.

Notwithstanding this, Council feels that New Zealand's scientific programme in Antarctica should be maintained at about its present level, and present topographic and geological survey work should be continued until the reconnaissance of the Cape Adare - Beardmore section is completed.

NUCLEAR SCIENCES

In 1957 the Isotope Division of the Dominion Physical Laboratory became a separate unit of the Department as the Division of Nuclear Sciences. In 1959 this was changed to the Institute of Nuclear Sciences

and charged with the responsibility of the installation of a 3Mev Van de Graaff accelerator and later of a 1 MW research reactor, these facilities to be available for research within the Institute's programme and for university staff and students.

Although the accelerator is on hand, the time schedule for the acquisition and development of the site for the Institute's buildings has lagged badly and Council is seriously concerned at the delay which is handicapping the development of the programme of research in nuclear sciences.

RESEARCH GRANTS TO BODIES OUTSIDE THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

The Council continues to recommend annual grants to research workers in the universities and to other institutions to encourage research, frequently in subjects ancillary to the main programme of the D.S.I.R.

As mentioned above, the policy in respect of grants to the universities has been under consideration during the past year and in future there will be some changes in the basis of support.

In addition to those for university research, grants are made to allied institutions, societies, and research associations. At the Cawthron Institute in Nelson and at the seven incorporated research associations, such grants provide approximately half the total funds available.

These grants, although met from the vote of the D.S.I.R., are outside the regular programme of research and scientific services of the Department itself. Details of grants paid last year are as follows:

Grants Paid in 1960-61 to Research and Allied Institutions

	£	£
Canterbury Agricultural College	10,000	
Massey Agricultural College	9,500	
University of Auckland (Seagrove)	4,000	
University of Canterbury—		
Industrial Development Department	8,000	
Radio Research (Meteors)	1,550	
Victoria University of Wellington	760	
		33,810
Cawthron Institute	..	11,750
Carter Observatory—		
Statutory	2,250	
International Geophysical Year	600	
		2,850
Royal Society of New Zealand	..	5,030
Commonwealth Agricultural Bureaux	..	18,680
U.K. National Institute of Oceanography	..	2,500
International Atomic Energy Agency	..	7,196
Grants unspecified	..	2,960
Incorporated Research Associations—		
Dairy Research Institute (N.Z.)	35,826	
Meat Industry Research Institute of New Zealand (Inc.) ..	24,450	
New Zealand Fertiliser Manufacturers' Research Association (Inc.)	6,000	
New Zealand Leather and Shoe Research Association (Inc.) ..	6,400	
New Zealand Pottery and Ceramics Research Association (Inc.) ..	6,400	
New Zealand Wool Industries Research Institute (Inc.) ..	7,100	
Research Institute of Launderers, Drycleaners and Dyers of New Zealand (Inc.)	5,200	
		91,376
		£176,862

DEPARTMENTAL EXPENDITURE AND STAFFING

Expenditure by the Department in 1960–61 is shown in the table below:

Table of Expenditure, 1960–61

—	Staff 31 March 1961	Salaries	Other Expenditure	Total Expenditure 1960-61	Voted 1960-61
		£	£	£	£
Head Office	72	67,836	12,593	80,429	82,900
Animal Ecology Section	10	12,348	5,965	18,313	14,250
Applied Mathematics Laboratory	22	22,348	3,491	25,839	25,800
Auckland Industrial Development Laboratories	35	35,927	12,700	48,627	48,200
Botany Division	26	29,349	16,254	45,603	45,850
Crop Research Division	56	49,185	23,546	72,731	72,200
Dominion Laboratory	148	134,321	67,100	201,421	202,200
Dominion Physical Laboratory	147	144,714	80,400	225,114	218,500
Entomology Division	30	29,051	14,989	44,040	43,900
Fats Research Laboratory	16	17,446	6,184	23,630	22,000
Fruit Research Division	30	30,601	27,846	58,447	57,300
Geological Survey	89	84,771	29,761	114,532	110,500
Geophysics Division	71	73,486	51,399	124,885	115,700
Grasslands Division	87	73,697	58,080	131,777	128,000
Hop Research Station	5	4,743	2,366	7,109	7,500
Information Bureau	25	21,666	33,190	54,856	56,500
Institute of Nuclear Sciences	33	28,496	64,621	93,117	98,200
Oceanographic Institute	27	25,425	48,814	74,239	67,800
Plant Chemistry Division	31	28,548	14,677	43,225	42,100
Plant Diseases Division	63	64,885	31,948	96,833	100,100
Scientific Liaison Service	6	8,598	5,726	14,324	15,300
Soil Bureau	72	79,293	32,695	111,988	113,800
Tobacco Research Station	6	6,429	4,539	10,968	10,700
Wheat Research Institute	12	13,289	2,979	16,268	15,500
Research General	..	..	15,072	15,072	15,300
Scholarships	..	..	10,500	10,500	11,000
Miscellaneous	..	..	628	628	700
Grants—					
Universities and agricultural colleges	..	..	33,810	33,810	34,050
Incorporated research associations	..	..	91,376	91,376	91,380
Statutory and miscellaneous	..	..	51,676	51,676	52,770
Antarctic Division	29	43,739	42,869	86,608	77,000
	1,148	1,130,191	897,794	2,027,985	1,997,000
Less recoveries	..	..	..	64,499	60,300
Net expenditure	..	..	..	1,963,486	1,936,700

The actual staff employed on 31 March 1960 was 1,121 and by 31 March 1961 this had increased to 1,148.

The staff at 31 March 1961 (figures for previous year in parentheses) comprised professional, 422 (401); clerical, 180 (180); technical, 473 (470); others, 73 (70).

M. M. BURNS, Chairman.

SECRETARY'S REPORT

The Hon. W. B. TENNENT, Minister in Charge of the Department of Scientific and Industrial Research.

I HAVE the honour to submit herewith the annual report of the Department for the year ended 31 March 1961.

STAFF

Attention has been focussed in the past year on losses of trained scientists from New Zealand. The position in D.S.I.R. over the last few years has been as follows:

Year	Total Scientific Officers	Number Going Overseas	Total Losses (Including Deaths and Retirements)	
			No.	Per cent
1956–57	366	3	25	6·8
1957–58	369	1	17	4·6
1958–59	383	14	35	9·1
1959–60	390	5	19	4·9
1960–61	401	9	30	7·5
Average ..	382	6·4	25	6·55

The 30 losses during 1960–61 were distributed as follows:

Overseas position	9
N.Z. universities	2
N.Z. industry	5
Research associations	2
Church Ministry	1
Farming	1
Retirement, etc.	6
Terminating short-term appointments	4
	30

One-third of the losses in 1960–61 were unavoidable in the sense that they were retirements, or termination of short-term appointments for work during the university vacation or for the summer season in Antarctica. During the same period 12 graduates were appointed to the staff from overseas and 39 from within New Zealand. An important factor not disclosed by these figures is that our losses are nearly all of experienced scientists while our appointments are mostly of recent graduates. Such losses of senior staff can be particularly damaging when they involve branch directors or section leaders who have been providing scientific leadership for a group.

An important consideration is the effect that losses may have had on the calibre of staff within D.S.I.R. and an analysis of this position is shown in the table below:

Academic Qualifications of Professional Staff of the Department of Scientific and Industrial Research

	M.Sc., M.Agr.Sc., or M.A.			B.Sc., B.A., or B.Agr.Sc.	Engineering	Overseas Degrees	Other	Total
	Honours		Third Hons. or Pass					
	First	Second						
1/4/50	49	84	45	141	37	25	8	389
31/3/55	61	105	55	83	26	33	9	372
31/3/60	82	100	53	89	22	46	9	401
31/3/61	87	100	52	97*	22	56	8	422

*Includes five who have completed M.Sc. but results not yet known.

Included in the above figures are:

	D.Sc.	Ph.D.
1/4/50	10	24
31/3/55	10	47
31/3/60	14	79
31/3/61	13	87

From the above table it will be clear that the overall calibre of D.S.I.R. staff, as judged by academic qualifications, has shown a substantial improvement over the 11 years since 1950. This improvement is the result of conscious policy on the part of the Department, and has been achieved in spite of the overall shortage of highly qualified graduates.

In the five years 1955–59, the average annual number graduating M.Sc. in physics, chemistry, and mathematics in New Zealand universities was as follows:

Grade of Pass	Physics	Chemistry	Mathematics
First Honours	2·6	7·0	5·0
Second Honours	5·0	8·4	3·2
Pass	2·8	5·8	5·2
Total for New Zealand ..	10·4	21·2	13·4

Practically every science graduate gaining first-class honours M.Sc. can, if he wishes, obtain a scholarship to further his studies overseas, and a high proportion do so. Half of these – the best of our science graduates – do not return to New Zealand but accept posts overseas.

This represents a loss of talent which New Zealand cannot afford.

Some of this loss is inevitable where a graduate's interests have crystallised in a field where openings are not available in New Zealand, e.g., thermo-nuclear energy, or where a man of outstanding brilliance could not find scope for his talents in New Zealand. In the majority of cases, however, New Zealand simply fails to provide conditions comparable with those available in other countries.

The retention of a high proportion of our first-class honours graduates in employment in New Zealand is fundamental to the development of efficient scientific education and research in the national interest. As Sir Edward Appleton, Vice-Chancellor of the University of Edinburgh, said recently: "You can have the most wonderful and expensive facilities but, without the right people, nothing happens."

Whatever arguments there may be about the most efficient form of research organisation there is complete unanimity among scientists that the crux of the problem is to recruit and retain an adequate proportion of high-calibre scientific staff. This is particularly important for directors of research at the branch level, e.g., director of a research unit such as Dominion Laboratory, Grasslands Division, etc. A good director can by his leadership greatly improve the quality and output of scientific work from a laboratory and he exerts a profound effect on the quality of recruits offering themselves for employment.

The ability of a scientific organisation such as D.S.I.R. to attract and retain high-calibre scientists on its staff depends on a number of factors. Without being in any way exhaustive, these include:

(a) The opportunity to undertake interesting and challenging research under good scientific leadership, and with buildings and equipment adequate for the tasks in hand.

(b) Opportunity to publish his results and make his mark as a scientist: this makes it difficult to recruit good staff for work classified as secret unless there are special compensations such as new and exciting fields of work, e.g., nuclear science in the 10 years after the war.

(c) Facilities for keeping in touch with other workers in the same field through good library services, attendance at conferences, overseas travel, etc.: this is particularly essential in New Zealand because of our isolation and small scale operations, e.g., in some fields there may be only one or two specialists in New Zealand.

(d) Salaries and other conditions of employment reasonably comparable with alternative employment offered in other organisations or other countries. High-quality scientists are in short supply throughout the western world and the scientist's training places him in a world market.

The recent increase in scientific salary scales still leaves a wide margin between New Zealand salaries and those overseas. The measure of this discrepancy is illustrated in the table below.

Percentage of Scientific Officers in Major Research Organisations Receiving Salaries in Excess of

	Stg. £2,000 per annum per cent	Stg. £3,000 per annum per cent
D.S.I.R. (New Zealand)	13·5	0·24
Australia	65	6
United Kingdom	40	9
Canada	72	27

Except in the case of New Zealand, the above figures are approximations, since the limits chosen in every case split a salary grade. They are, however, sufficiently accurate for purposes of comparison, though obviously they take no account of differences in cost of living or levels of taxation.

Put another way, the figures in the above table show that the chances of a scientist receiving a salary of over £3,000 per annum are 25 times greater in Australia and 37 times greater in the United Kingdom than in D.S.I.R. in New Zealand. These are odds which the young graduate can scarcely ignore.

Inset 2

However, it would be a mistake to place too much emphasis on salaries alone. I believe that while relative salaries are a contributing factor in loss of staff and of young graduates to posts overseas, they are rarely the over-riding factor. The research worker or young graduate is concerned firstly with the opportunity to make his mark as a scientist; this needs adequate facilities and good leadership. Secondly, he is concerned that the work he is doing is valued by the community in which he lives.

Both these factors are much more subjective and less easily assessed. The scientist assesses them by the support accorded research and the priority given by successive governments in New Zealand to requests for buildings, facilities, and staff to meet the scientific needs of an expanding economy – an economy which the scientist realises is increasingly dependent on the results of research for its future development.

Such an examination does little to reassure the scientist that the community recognises the contribution science has made to national development in the past, or the larger contribution it is capable of making in the future.

He knows on the one hand the dividends which research is providing, such as "Aotea" wheat, which is saving New Zealand £1,000,000 a year in overseas exchange, and the gains in farm production which have resulted from improved strains of grasses and clovers, or from the solving of minor element deficiencies such as cobalt, molybdenum, or sulphur. On the other hand he knows that, after payment of salaries, the sum available to D.S.I.R. for scientific work had exactly the same purchasing power in 1959–60 as it had in 1949–50. He compares this with the fact that Britain doubled the amount spent on civilian research in the three years 1956–59.

It is not surprising that some of our most able scientists and most gifted young graduates leave New Zealand – the surprising thing is that so many remain. We should not continue to trade on their loyalty to New Zealand.

SENIOR RESEARCH FELLOWSHIPS

In 1960 approval was given for the establishment of two senior research fellowships to bring overseas research workers to New Zealand to work in D.S.I.R. laboratories for periods of up to two years. These fellowships were advertised for the first time last year.

Over 230 inquiries were made by scientists in 26 different countries and 82 firm applications were received. The two fellowships available were awarded to Dr R. G. Coleman, of the United States Geological Survey, and Dr B. H. Howard, of the Rowett Research Institute, Aberdeen. Both will be arriving in New Zealand later this year.

RESEARCH

In the following section a brief review of work completed during the year is given. Items that appear to be of general interest have been selected and are outlined in non-technical terms with sufficient background information to explain the significance of the work. No attempt has been made to cover all work completed, but a complete list of all scientific papers published during the year is given following the list of projects in each branch.

THE NEW *Flora of New Zealand*

More than 10,000 species of plants grow in New Zealand and each one has an internationally accepted name by which it can properly be designated in scientific, legal, and other precise documents. The so-called lower plants – seaweeds, fungi, lichens, and mosses – account for more than half the total, and plants deliberately introduced for gardens, pastures, crops, and forests, together with weeds that have arrived uninvited, make up perhaps a quarter of the whole, while the native herbs, ferns, shrubs, and trees number about 2,000 species. Some three-quarters of these indigenous plants are described in the first volume by the late Dr H. H. Allan, of the new *Flora of New Zealand*. This work, completed in 1960, is part of a major project of the Botany Division.

The naming of New Zealand plants, on the basis of their relationships with those of other parts of the world, was almost the first scientific activity in this country, beginning when Captain Cook put his two botanists ashore at Poverty Bay nearly two centuries ago. Since then it has become increasingly important to many branches of science and technology that different species of plants should be distinguished from one another, and that each name should be applied in the same way by all users. A measure of this need is that 2,000–3,000 specimens are identified each year by the Botany Division for a wide range of official, commercial, and private inquirers.

Because knowledge of plants increases continuously, a periodical stocktaking is necessary, when someone must try to prepare an inventory enumerating all the names and providing descriptions that stress the distinguishing characters. The publication of such an inventory or flora is an infrequent event and is regarded as a landmark in the botany of any country. Sir Joseph Hooker's *Flora Novae-Zelandiae* – the first comprehensive work – appeared in 1854–55, followed 10 years later by the same author's *Handbook*. The present book of reference – Cheeseman's *Manual of the New Zealand Flora* – was issued in 1906, and a revised edition was required by 1925. The new volume brings together the results of 35 years of vigorous inquiry, results which have been published in journals and monographs in many parts of the world, some of them not easily accessible to New Zealand workers. Ferns, conifers, and most of the flowering plants are treated in this volume which is to be followed by a second volume dealing with the monocotyledons which include grasses and sedges: a third volume will deal with the naturalised flora.

AOTEA WHEAT

Aotea wheat, bred at the Crop Research Division and released in 1957, has become the most important variety in New Zealand. In 1958 grain of this variety amounted to only 0·02 per cent of the total New Zealand grown wheat, but in 1960, 85·68 per cent of the total production of grain handled for milling was Aotea.

In the season 1959–60, 118,660 acres of Aotea wheat were harvested, producing 6,404,890 bushels at an average yield of 54·0 bushels per acre. According to information made available by the Government Statistician from a county survey of areas and yields of individual varieties, the new variety was grown on 78 per cent of the land sown to wheat. The best yields were obtained in Wallace County where Aotea

averaged 78 bushels per acre on 3,889 acres; in Clutha County, 77 bushels on 2,046 acres; in Bruce County, 76 bushels on 1,176 acres; and in Southland County, 74 bushels on 6,947 acres. High average yields were obtained in the majority of the counties where wheat is the predominant cereal crop.

The total area of all crops covered in this census was 152,493 acres, which produced 8,106,191 bushels at an average yield per acre of 53·2 bushels. The high average yield being achieved with the new varieties, and general improvements in soil fertility have caused a significant improvement in the farming economy. Nineteen years ago, in 1940–41, it required 243,197 acres to produce a crop of 8,305,865 bushels, a harvest comparable with that produced on only 152,000 acres in 1959–60. The comparison illustrates the effectiveness of scientific wheat breeding on yield.

DISTRIBUTION OF SELENIUM IN PLANTS

In 1957 it was shown that selenium is an essential trace element for animals. Incorporation of small amounts of selenium in the diet protects animals from a number of degenerative lesions where vitamin E gave partial protection. New Zealand workers have shown that dosing sheep with as little as 1 mg per month of sodium selenite gave protection from muscular dystrophy ("white muscle disease"). Furthermore in many areas where "white muscle disease" is not observed, the weight of sheep is improved by selenium administration.

The total selenium content of pasture herbage is of the order of 0·01 p.p.m. dry weight, which is 1,000 times less than the average content of trace elements such as copper and zinc. Chemical determination of selenium in such small amounts presents experimental difficulties. Radioactive selenium is therefore being used at the Plant Chemistry Division to examine the distribution in plants. Sodium selenite of high specific activity is being incorporated in plant-culture solutions and, after a suitable period has elapsed for uptake and assimilation, the plant tissues are subjected to chemical fractionation. Species from three plant groups have been chosen:

(a) Selenium accumulators (containing up to 5,000 p.p.m.) – *Neptunia amplexicaulis* (an indigenous Queensland plant);
(b) An intermediate group (containing up to 50 p.p.m.) – wheat;
(c) Some pasture species (containing up to 1 p.p.m.) – white clover, ryegrass.

Results obtained from the first two groups of plants show marked difference in the distribution of radioactivity. With leaves and stems of *Neptunia* 90 per cent of the radioactivity can be extracted in boiling aqueous ethanol, whereas with wheat plants only 20 per cent of the radioactivity can be extracted in boiling aqueous ethanol and water. In the *Neptunia* leaves most of the extractable radioactivity is in selenite and in two compounds, whose identity is being studied.

It is interesting that so much of the radioactivity in the wheat leaves is not readily extractable. Much of the unextracted radioactivity from wheat herbage can be slowly solubilised by shaking with 0·01 *M* phosphate, pH 7·6 at 37°c in the presence of antibiotics. The dissolved radioactivity is mainly dialysable and behaves as a mixture of selemethionine and methionine selenoxide when subjected to paper chromatography in four solvent systems and to paper electrophoresis at

pH 2·7. Thus this material is apparently not bound to proteins by peptide links and further experiments are being conducted to attempt to elucidate the state of binding in the plant tissue.

Some experiments on the excretion of orally-administered Se^{75}-selenite by sheep are being carried out. It has been found that 50 per cent of the radioactivity ingested can be recovered in the faeces in 72 hours. The nature of the chemical binding of the excreted Se^{75} is being examined, and results to date are consistent with approximately 50 per cent being present as elemental selenium and 50 per cent present in protein-bound form.

GENETIC VARIATION IN PASTURE PLANT CONSTITUENTS

The criteria employed in the past for the selection of improved strains of grasses and clovers have of necessity been based on yield per acre per annum or seasonal yield. This work has produced important new strains of pasture plants but these can be improved still further if quality of the herbage as well as quantity can be taken into account. It is known that there are differences in chemical composition between different pasture species such as ryegrass and white clover. For example, the clovers have more starch and calcium and cobalt than have the grasses. It is now being realised that the individual plants in a single species such as ryegrass, beside showing a range of production, can vary in their chemical composition. It is important for the plant breeder to know the extent of this variation. In cases where the variation is large, progeny can be selected for their optimal nutritional qualities.

The Plant Chemistry Division, in collaboration with the Grasslands Division, is making a study of the variation of several herbage constituents in ryegrass plants. Earlier studies have shown that there can be a fivefold variation in the level of iodine in ryegrass plants grown on the same soil, and the factor determining the ability of the plant to accumulate iodine was shown to be highly heritable. This work is now being extended to an examination of the variation of a number of mineral and organic constituents of ryegrass plants.

It has been found that nitrate levels can vary up to tenfold among individual plants grown on the same soil. A particularly large variation – fiftyfold – has been observed in the levels of the alkaloid perloline. The nutritional significance of this has yet to be determined. Up to a twofold variation has been found for sodium, potassium, calcium, manganese, aluminium, copper, titanium, iron, zinc, sulphate, and phosphate. A number of these variations in mineral content can be correlated with variations in the cation-exchange capacity of the roots of the plants.

It is interesting to note that in no case to date has variation in a particular plant constituent been correlated with differences in herbage production of the plants.

DRYBERRY OF BOYSENBERRIES

Boysenberries were introduced to New Zealand from California about 1937 and at once proved to be a very popular fruit. Commercial plantings increased rapidly to 60 acres and would have continued to increase but for the appearance of a serious disease which caused fruit to become dry and shrivelled instead of swelling and ripening normally. In some seasons total crop losses were experienced and, as a result, the area

planted dropped to 24 acres. Symptoms of dryberry disease suggested a physiological cause or damage by mites, but attempts to control the trouble, based on these assumptions, failed. However, discovery this season of the causal organism, a downy mildew fungus *Peronospora rubi*, brings nearer the prospect of satisfactory control and the subsequent resumption of increased plantings of an attractive fruit with much better handling and marketing properties than most other similar small fruits. Although the fungus has previously been recorded from related small fruits in other parts of the world, references to it are rare. This is probably because the fungus, while causing widespread and serious losses, is an obligate parasite which cannot be grown in culture and which produces only slight and short-lived evidence (conidiophores) on the surface of infected berries and sepals. The same reason explains why discovery of the cause of dryberry disease of boysenberries has been so long delayed.

STUDY OF THE SYSTEMATICS AND TAXONOMY OF BACTERIAL PLANT PATHOGENS

In recent years there has been a general realisation in many parts of the world that the identification and classification of bacteria is in a very confused state. This is particularly true of bacterial plant pathogens and there are many reasons for this. One of the most obvious is that a morphological approach, i.e., a visual study of the organisms, which has been so successful in dealing with higher plants and animals, is much more difficult and considerably less informative when applied to bacteria. Furthermore, there has been no agreed theory of classification which could blend the findings of the ecologist, biochemist, morphologist, serologist, or bacteriologist into a unified scheme. Bacteria causing diseases of plants have frequently been named by pathologists with a cavalier indifference to the internationally accepted conventions for nomenclature, often after little comparative or systematic work and in the almost complete absence of type cultures. Even when type or comparative cultures were available from culture collections, these, when received, were often either mixed cultures or not true to type. This fact has not always been recognised by the recipient of the cultures. Much of the earlier work in plant bacteriology has been found to be incorrect because media and methods used for measuring the various characters of the bacteria were designed for use with medical or animal bacteria and are unsuitable for use with soil and plant bacteria.

The result has been that frequently the same micro-organism has been given several different names, and many of these are still in use. Much of the literature available on the identification of plant bacteria and on the cause of some diseases is quite erroneous. At present unequivocal identification of many bacterial plant pathogens is not possible by laboratory procedures. The effect of such confusion on attempts to identify and control plant diseases and to effectively carry out quarantine measures is obvious. Little wonder then that in the past few years there has been a renewed interest in bacterial taxonomy associated with new ideas and concepts. Unfortunately there are at present insufficient bacteriologists who are able and willing to make the required detailed studies of the systematics and taxonomy of bacteria.

At Plant Diseases Division a taxonomic study of bacteria causing plant diseases is in progress, beginning with the genus *Xanthomonas*.

Xanthomonas is the second largest group of plant pathogenic bacteria and a number of species cause considerable losses of economically important crops in many countries of the world. In the present study 330 cultures are being examined and compared by more than 60 different tests. These cultures consist of xanthomonads of 64 recognised species obtained from many parts of the world and a number of unidentified cultures, some of which are suspected of being xanthomonads. The purpose of this study is to define the limits of the genus *Xanthomonas,* to establish methods by which, if possible, the many species can be identified, and to remove from the genus those organisms which have been wrongly placed in it. A considerable amount of the work carried out in this study will be of use for extending the investigation to other groups.

BITING FLY

In recent years the biting fly, *Stomoxys calcitrans,* has proved very troublesome to dairy cattle, mainly in some parts of Waikato. Often the annoyance has been so great that milk yields have been seriously curtailed.

Trials have shown that covering is a satisfactory means of preventing biting fly from breeding in ensilage stacks. Of the three materials tested – plastic sheeting, soil, and sawdust – the plastic sheeting proved the most effective, mainly because of the almost perfect seal which can be obtained with it. Last season investigations were undertaken by the Entomology Division to assess the biting fly population, and degree of irritability occurring in dairy herds in their day paddocks when situated at varying distances from the main breeding sites of the pest. From the data obtained it is clear that the biting fly is no problem in areas which are free of ensilage stacks and other breeding media. Where a herd was normally grazing within a radius of approximately 400 yd from a number of heavily infested ensilage stacks, the degree of irritation in the herd was in many cases severe and the fly populations high, with as many as 60 to 70 flies per cow being recorded. No trouble was experienced in a herd which was estimated to be 1 mile from any major breeding source. Current trials are being undertaken to assess the effectiveness of covering ensilage stacks as a means of reducing biting fly populations in dairy herds.

NEW APPLE VARIETIES

The Fruit Research Division's apple-variety collection mentioned three years ago has now fulfilled its purpose, which was to find well coloured apples of high quality, earlier than Gravenstein or later than Delicious, which would crop well under local conditions.

All varieties earlier than Gravenstein proved to have too short a storage life for normal distribution, but some will find a limited use for direct sale to consumers. More success was achieved with later varieties. Five red apples of excellent quality were offered to representatives of the fruit industry for final selection. Despite the widely held belief that we already grow too many varieties, the quality and appearance of these apples were so good that two were accepted for extensive commercial trial. These are the Canadian variety Spartan, and a local seedling named Red Fresca.

GROWING APPLES WITHOUT POLLINATION

Some apples, although of excellent quality and flavour, are not grown commercially because their yield is too low. In another case a good variety, such as Jonathan, is unsuitable for Auckland, because in that district it does not bear regular heavy crops. Some means of improving the set of shy bearing apples would be of considerable importance to orchardists.

Until recently it has not been possible to obtain apple fruit development without normal pollination. For example the chemicals now regularly used commercially for artificial setting of tomato fruits have no effect on apples. It has now been demonstrated by the Fruit Research Division that seedless apples of some varieties can be grown to full size by treating apple blossom with gibberellic acid – a recently discovered plant growth substance. These results suggest that applications of gibberellic acid may have considerable practical value in overcoming fertilisation problems in apple crops.

BULK CURING OF TOBACCO LEAF

There has been little change in the methods of handling tobacco leaf since flue-curing was introduced during the latter part of the last century. To support the leaf for drying in the kiln it is tied on to sticks by hand. This operation takes more labour than any other during the growing season – up to nine girls being required to tie sufficient leaf to fill a kiln in one day.

In the past manufacturing procedure was linked to the conventional methods of handling leaf, but with the introduction of newer types of machinery in the factories the way is now open for the introduction of new methods in the handling of leaf.

Preliminary work last season indicated that the curing of leaf in bulk was a possibility, and this season the trials were carried a stage further. Instead of being tied on to sticks the leaf was held in a series of clamps. By this method the quantity of leaf normally tied on six sticks was dried in the space usually occupied by two, and loading required much less labour. Satisfactory drying was also accomplished with leaf packed tightly in baskets of wide mesh, with rods pushed through the leaf for additional support as the leaf dried. The curing was carried out in a small down-draught kiln where there was positive control of airflow and circulation.

The advantages of the system would be that a kiln could be loaded with much less labour than that required for tying and that much smaller kilns could be used.

WEASELS, STOATS, AND WILD FERRETS

Originally introduced for rabbit control, weasels, stoats, and ferrets are well established in many districts and are causing concern to those responsible for the conservation of native birds (especially in national parks) and of game birds. A study of these animals has been initiated by Dr W. H. Marshall, a Fulbright Research Scholar from the United States. Carcases of all three species, obtained from many parts of New Zealand, are being examined to determine food habits, reproductive rates, and age ratios. Preliminary indications are that mustelids have become less numerous since Wodzicki's (1950) survey and this may be due to a decline in the rabbit population; the stoat appears to be the

most successful species under present conditions, and future studies will be centred on this animal since its range extents throughout several national parks.

BIRDS IN KAINGAROA FOREST

Extensive, even-aged stands of conifers are notoriously prone to damage by sporadic plagues of insects. Since predation by birds can prevent insect plagues it is prudent to know in advance what birds live in such forests, and in what numbers. A preliminary study in Kaingaroa Forest has shown that there are nearly 500 adults birds per 100 acres in spring in compartments of *Pinus radiata,* but fewer in less well grown compartments of other exotic conifers. This density is comparable to that found in natural coniferous forests in North America, although there are no birds in New Zealand specially adapted to this habitat. The commonest species, in order of density, are chaffinch, whitehead, grey warbler, blackbird, and pied tit. Whiteheads in particular are much more numerous in *Pinus radiata* than in most native New Zealand habitats. The feeding habits of pied tits, whiteheads, gray warblers, and white-eyes were recorded quantitatively. Each species occupies a recognisably distinct niche in the habitat, although the last three all feed principally from the living foliage of the trees. A few pied tits have bred in nest boxes provided for them.

POPULATION STUDY OF ADELIE PENGUINS

A study has been made of the Adelie penguins breeding at the most southerly of all penguin rookeries – Cape Royds (latitude 77° 33′ S), Ross Island, Antarctica. In a period of four months the complete breeding cycle was observed, many of the observations being made on individually marked birds. Considerable fluctuations occur in the numbers of birds and nests at Adelie rookeries during different stages of the breeding season, and the detailed observations made at Cape Royds will be of value in assessing the size of other penguin rookeries from counts made during short-term visits. Historical records show that the penguin population breeding at Cape Royds has remained at much the same level over the last 50 years, and the only factor at present that could militate against its future survival would appear to be the increasing human disturbance. The study revealed that up to the time the young entered the sea there was a natural egg-chick mortality of about 50 per cent, and although predation by skuas accounted for 67 per cent of all chick losses, this amounted to only about 20 per cent of the total mortality. By comparison with some other rookeries there appears to be an abundant food supply for the birds in the Cape Royds area.

REFERENCE SOIL SITES

A set of 54 soils has been selected to represent a range of New Zealand soils used for agricultural, forestry, and highway purposes. Bulk samples from each profile have been collected and comprehensive chemical, physical, and biological measurements are being made. The selection was made after a systematic review of the numerous soil surveys and laboratory analyses carried out during the last 30 years. During that time several changes in methods of analysis have been made as a result of the introduction of new ideas and the availability of new techniques, and it has become increasingly difficult to use results from the older

methods. The present sampling programme will provide a base line for general interpretation and sufficient material for comparison of results by past, present, and future methods. A mounted monolith of each of the selected profiles is being prepared as a permanent exhibit which may be used for detailed reference. The detailed results will be published in a descriptive handbook of New Zealand soils for the International Soil Conference to be held in New Zealand next year and will be available for general reference and teaching purposes.

SOILS AND DENTAL CARIES

Officers of the Dental Research Committee of the Medical Research Council working in collaboration with officers of the Soil Bureau have shown that a lower incidence of dental decay in Napier children as compared with Hastings children (prior to fluoridation) is associated with soil differences. These differences are reflected in the trace element composition of vegetables produced on these soils. Napier vegetables were higher than Hastings vegetables in molybdenum, aluminium, and titanium, and lower in copper, manganese, barium, and strontium.

When rats were fed a diet designed to produce dental decay but supplemented with mineral ash from Hastings vegetables they showed a high level of dental caries. However, rats fed on a similar diet but with ash from Napier vegetables showed a strikingly lower incidence of caries. Soil and dental evidence suggest that molybdenum is of particular importance.

LOW-TEMPERATURE YEASTS

Cultures of Antarctic soils collected in the summer of 1960–61 have yielded at least four more species of cold-demanding yeasts. These are unusual in that their optimum temperature is in the region of 10°C (50°F), the maximum, 20°C (68°F). The presence of organisms with these properties in such number and variety is of both theoretical and practical interest. All are likely to be important in the spoilage of chilled and even frozen food while some are potentially important as agents in low-temperature alcoholic fermentations.

RESEARCH ON VOLCANIC ASH SHOWERS

Officers of the Soil Bureau and New Zealand Geological Survey have studied the layers of volcanic ash (often called "ash showers") that cover large areas of the North Island. Apart from the ash from recent eruptions of the National Park volcanoes, and from the Tarawera eruption of 1886, all of these ash showers were erupted before European settlement of New Zealand.

Some of them are in places many feet thick, and can be traced, getting steadily thinner, for distances of tens, even hundreds of miles. They are obviously the debris from very large eruptions. The application by the Institute of Nuclear Sciences of the technique of radiocarbon dating has shown that many of these showers, notably in the Taupo district, have been erupted within the past few thousands of years. For reckoning the likelihood of large eruptions in the future it is important that as much as possible should be learnt about how long ago each of the ash layers was erupted, where it came from, and what type of eruption produced it. Another reason for studying ash showers is that they are the parent materials of the soil over much of the central North Island and Taranaki.

The New Zealand Geological Survey recently commenced an intensive mineralogical study of the ash showers. Many of the showers look so much alike that it has proved very difficult to trace them across country and correlate them from place to place; one of the first problems tackled has been to find ways to identify them mineralogically. An initial study of the sequence of rhyolitic pumice showers in the Taupo district so far has shown that some techniques may make this identification possible, though the problem is clearly no easy one.

One method used is to pass samples of the ash through sieves and to study the proportions of the various minerals and of volcanic glass particles in each sieve fraction.

Another is to float off the lightweight minerals in an ash sample with bromoform liquid, leaving behind the heavy iron- and magnesium-bearing minerals for study; if the proportions of the minerals differ from ash shower to ash shower this may be a means of identification. So far this technique has not been very rewarding.

Determination of small differences in the refractive indices of the volcanic glass particles in ash showers has been a rather more successful technique. But the most promising method has been a study of chemical variations in the ash showers, both of their total composition and more particularly their content of trace elements such as molybdenum, vanadium, and cobalt.

Another fruitful line of research has been the study under the microscope of the shape and size of the steam holes in pumice fragments of different showers, and of other physical properties of the pumice. Study by X-ray diffraction of the glass particles is also showing up differences from shower to shower that may be useful in identification and correlation.

There is reason to expect that this detailed research on ash showers will greatly help understanding of the late volcanic history of New Zealand.

"Four-mile" Geological-map Project

The New Zealand Geological Survey's "four-mile project" commenced in 1956 with a scheduled date of completion of 1964. The aim is to publish 28 geological maps on a scale of 1:250,000 (approximately 4 miles to 1 inch) covering the whole of the country. At present, field work compilation and draughting is proceeding in all but four sheets, of which two are in the North Island and two in the South Island. Already six sheets have been published, two are in the press and no less than five in the hands of the cartographers, while the remaining sheets are in various stages of compilation.

The project has already revealed new and interesting aspects of New Zealand geology and has indicated areas that would merit more detailed examination. Not only is this detailed examination desirable from the point of view of geological knowledge, but in several cases the recognition of previously unknown geological structures, for instance in Fiordland and north-west Nelson, has shown up areas that might contain minerals of economic value.

The increasing use that is being made, outside the Geological Survey, of these 4-mile maps as they appear is indicative of the need for the project. One notable use is by the Town and Country Planning Division of Ministry of Works which has decided to use these maps in its regional resources surveys.

The rate of progress of this 4-mile project is such that its completion by 1964 can be confidently expected. No revision is contemplated until after that date, when sheets will be revised in accordance with further detailed explorations. It is likely that in many cases the revision will await detailed work proceeding on critical areas within the 4-mile districts, as by then there will be a need for the N.Z. Geological Survey to move back to 1-mile scale maps in order to maintain continuity of the descriptive bulletin series on New Zealand geology.

SHORT-TERM FACTORS INFLUENCING NEW ZEALAND LAMB PRICES IN THE UNITED KINGDOM

Recently (December 1960) a paper with the above title containing the results of a study made at the Applied Mathematics Laboratory was published in the Economic Record.

While a large part of this Department's research is devoted to increasing the quantity and quality of our farm production, it is no less important to ensure that marketing of what is produced gives a maximum return to the country. The timing of the arrival of our lamb on the English market is one of many factors which has an important bearing on this.

While it is a matter of commonsense to avoid placing excessive supplies on the market at one time and so depressing the price, it is a more intricate matter to predict what would have been the effect on price if an increased quantity had been placed on the market at some other time, for example, early in the season. Yet it is only with this information that it is possible to assess the likely return to New Zealand, and the premium which can justifiably be offered for early killings.

Many factors other than New Zealand supplies affect the price at Smithfield. Among those considered were pitchings at Smithfield of United Kingdom mutton and lamb, of fresh beef, and of frozen and chilled beef; United Kingdom total pork supplies; United Kingdom total beef supplies; United Kingdom total mutton supplies; and average weekly arrivals of New Zealand lamb. When a detailed statistical study of these and a number of other factors was carried out it was found that most of the variation in the price of New Zealand lamb at Smithfield could be explained in terms of two factors: the rate of arrival of New Zealand lamb; and the quantity of imported lamb held in store in the previous month. When the prediction equation based on these two factors was tested over a subsequent period it gave a reasonably satisfactory prediction of the price. The inclusion of other factors gave only a slightly better prediction.

While there are clearly limits to the degree to which killing pattern can be altered, it is undoubtedly true that given an economic incentive some farmers can get some of their lambs ready for killing earlier in the season. This type of model makes it possible to predict the effect on our overall return of this or some other variation in our killing and shipping pattern.

This study, by itself, can only give a crude picture, but it does emphasise the possibility that detailed econometric studies of this type might have a very significant effect on the payments which New Zealand receives for her primary products.

CONTROL OF MOISTURE IN WOOL

It is well known that the weight of wool bales will vary in accordance with the relative humidity of the surrounding air, and commercial "regain" certificates are available to correct the weights of bales. These certificates are based on standard values of moisture content, usually about 16 per cent, but varying for different grades of wool and different countries. Regain certificates are not used in all cases where wool is exported from New Zealand, and actual bale weights are then used. The amount of water in export wool is sometimes unknown, and it can happen that wool is sold with a moisture content lower than the standard value. Since New Zealand exports 200,000 tons of wool annually, a knowledge of the moisture content of wool is therefore vital. It is particularly important where wool is scoured or otherwise wet processed, and is machine dried before baling. If the wool is overdried or underdried the changing bale weights can cause confusion and financial loss.

The drying process in large wool driers must be controlled so that wool is produced to a consistent desired moisture content, and for this it is necessary to have available a rapid method of moisture analysis. A study of the problem by the Dominion Laboratory showed that a minimum sample weight of 3 lb is necessary to be representative of the output of a drier, and that electronic or humidity measurements are not accurate enough for process control. A rugged tester has been developed, in which the sample is dried for 5 minutes in hot air, followed by weighing on scales calibrated directly in water content (corrected for buoyancy). About 20 of these machines are now in use in scouring works and freezing works throughout New Zealand, controlling the drying process. Many bales have subsequently been checked by the Wool Testing Laboratory of the Department of Agriculture, and 85 per cent of the bales so tested were found to be within 1 per cent of the desired moisture content. It is hoped that these testers will eliminate the troubles caused by uncertain weights of wool bales.

GEOTHERMAL CHEMICAL INVESTIGATIONS

The Department continues to assist with power development utilising natural hot-water resources at Wairakei. The deeper drillholes provide an excellent opportunity of studying a natural hydrothermal system in cross section. About 65 drillholes penetrate 2,000–3,000 ft of porous volcanic pumice debris, capped by impermeable mudstone beds. Hot water at 260°C enters the porous material from greater depth through fissures in the underlying layers of ignimbrite rock which exist throughout the Wairakei area.

It has been established that almost constant concentrations and inter-relationships of chemical constituents exist in the waters from all over the Wairakei field. Also, there has been little change in these chemical characteristics in the eight years since major withdrawal by drillholes commenced. Evidence is therefore in favour of a single large primary reservoir deep beneath the ignimbrite layers. The great depth of this primary reservoir is indicated by the presence of appreciable concentrations of rare metal ions, such as caesium, which are not available for leaching in known surface rocks. Recent chemical work at the Dominion Laboratory, together with temperature measurements in drillholes, has shown that hot water enters at the base of the porous

pumice beds through three major fissures. Certain dissolved constituents, such as potassium and rubidium, become absorbed from the waters as they move within the pumice. Other ions, such as calcium are leached from the rock, while concentrations of ions such as chloride and sodium are almost unaltered. Movements of the hot waters can therefore be traced through changes in the ion ratios sodium/potassium, sodium/rubidium, sodium/calcium. Similar results are obtained by surveying the concentrations of silica, which is gradually deposited from solution into the rock.

This information leads to the approximate positions of feeding fissures, and is invaluable when sites for new drillholes are being selected.

SEISMOLOGY

The study of the origin, incidence, and effects of earthquakes is a matter of great public interest in any country where earthquakes frequently occur. The Seismological Observatory maintains a network of seismograph stations throughout the country to provide information needed by the building industry in determining seismic safety factors, and by the Earthquake and War Damage Commission in assessing claims. In addition New Zealand has a special contribution to make to the world system for recording major earthquakes, by virtue of our location in a sparsely occupied region of the earth. Apart from the local network New Zealand maintains stations in Samoa, Fiji, Kermadec Islands, and also at Hallett Station and Scott Base in Antarctica. The importance of these stations becomes clear when it is realised that the closest stations to these in an easterly direction are in South America.

Seismological research in New Zealand normally arises out of the recordings obtained from these stations, thus obviating the expenditure of money on instruments required solely for research purposes. The nature of earthquake activity in the New Zealand region, combined with our geographical location and geological conditions, gives us an exceptional opportunity to study certain fundamental aspects of seismology. Attention is currently being devoted to the thickness of the earth's crust, a property having basic importance in geology and geophysics; this will also contribute to the more accurate location of earthquakes. The first definite proof that a continental type of crust underlies the Antarctic ice cap was derived from earthquake recordings at the New Zealand seismograph stations in Antarctica. These stations have also contributed to a better understanding of the origin of microseisms.

The problem of earthquake mechanism stands out as one of the most urgent topics of modern seismology. The associated question of the relationship between earthquakes and geological faults is of pressing importance to New Zealand. Shallow and deep earthquakes are common in New Zealand, and studies relating to the mechanism problem are being carried out in both these fields.

NEW ZEALAND TIME SERVICE

The Geophysics Division is responsible for determining and maintaining accurate time in New Zealand. Apart from the general public, the chief demands for correct time come from shipping which requires it for navigation purposes, from railway stations, post offices, broadcasting stations, and from the Seismological Observatory which operates a

network of earthquake-recording stations throughout New Zealand. Astronomers and other scientists require very accurate time, in some cases to an accuracy of 0·01 or even 0·001 seconds.

The Time Service Observatory was established at Wellington in 1868 and equipped with a transit instrument for determining time from astronomical observations and several pendulum clocks for maintaining correct time between observations. Originally the time signals were provided by extinguishing coloured lights on a mast outside the observatory. However, the introduction of the telegraph and telephone made a broader network possible and since 1920 regular time signals in the form of time pips, have been transmitted throughout New Zealand by radio.

Since the establishment of the observatory advances in science and technology have made increasing demands for more frequent and more accurate time signals. Before 1950 the observatory was unable to meet these requirements adequately and the obsolete equipment required almost continuous repair. The requirements of the International Geophysical Year could not be met with the old equipment and a start was therefore made to replace it with modern electronic clocks, recording, and transmitting equipment. When this replacement programme is completed during 1961 it will be possible to meet modern requirements by providing a time service which is accurate to 0·01 seconds or better.

SMALL-SCALE STEELMAKING BY THE ALUMINO-THERMIC PROCESS

Although there are some 18 iron foundries in Auckland, none of these is equipped to produce steel castings, as the demand is small and intermittent and the conventional equipment expensive. There are a few steel foundries in other centres in New Zealand, but these are engaged mainly on large castings, so that the manufacturer requiring a few small steel castings is often forced to import them or to redesign his project to use other and perhaps less suitable materials.

Investigations at the Auckland Industrial Development Laboratories have been directed towards the use of local ironsands and waste aluminium turnings as a thermite mixture. By careful control of the ratio of aluminium to ironsand, the iron can be reduced without reducing the titanium content of the sand, which is left in the slag. Careful selection of the aluminium turnings is necessary to avoid the introduction of harmful metallic elements into the steel, or gases from swarf contaminated with cutting oil.

To date, some 70 casts have been made, using a refractory-lined steel crucible holding 45 lb of ironsand intimately mixed with 10 lb of aluminium. A hole, ½-in. in diameter, is made through the bottom of the crucible, which is plugged with a projecting steel peg. The reaction is commenced by heating a small area with an oxyacetylene torch or by using a chemical starting mixture, and the reaction takes from one to three minutes to reach completion.

The steel peg is then tapped upwards and the molten steel, at a temperature of about 1,800°c, is released into a suitable receiver underneath the crucible, which is withdrawn as soon as the slag commences to run. This molten steel is then deoxidised and cast into sand.

At this tapping temperature, up to 20 per cent of steel scrap may be added, or up to 12 per cent of such alloying elements as chromium.

Steel castings meeting all the requirements of the relevant British Standard Specification have been consistently produced by this method.

Experimental work is being undertaken to determine whether this method may be used economically to produce ferro-manganese from local manganese ores.

DEVELOPMENT OF A FOETAL HEART-RATE RECORDER

The foetal pulse rate is one important indication of a baby's condition prior to and during labour, a period when the foetus may be subjected to many stresses, and when there is a need for a reliable method of indicating any onset of foetal distress without delay.

The recording of the foetal heart rate is, however, complicated by the presence of the much more powerful maternal heart pulse and the many other sources of interference that occur during labour.

Successful efforts have been made at A.I.D.L. to construct a foetal heart-rate recorder using a heart-sound pickup which delivers this conglomeration of sounds to a system which is specially designed to deal with a foetal pulse which may be for most of the time even below the level of background noise. This is accomplished by first sensing the rate of change of the pulse rate and excluding all pulses whose periods differ by more than say 10 per cent per pulse.

To do this, a voltage analogue is produced proportional to each pulse period, and the analogues of the last two consecutive pulses are stored and compared.

If the voltages differ by more than the pre-set limit the last pulse period is rejected, and recording does not resume until consecutive pulses are once more within the limit.

It is not inconceivable that noise impulses may occur with a periodic difference within the acceptable limits, but it is unlikely that such a coincidence would persist for more than a few consecutive pulses. A delay circuit is therefore provided which ensures that the rate is not recorded unless a certain number of consecutive pulses occur within the acceptable limit.

The instrument therefore writes the record only when it is satisfied that consecutive true pulses are being received and leaves small blank spaces in the periods when no useful information has been received. A continuous record of foetal heart rate is therefore plotted on a paper chart recorder.

HYBRIDISM OF PINE

The variable timber quality of *Pinus radiata* grown in New Zealand could be an environmental effect, or could be inherent in the species as a result of hybridism between *P. radiata* and another pine, such as *P. attenuata*. The timber trees in New Zealand are only two generations remote from the indigenous pine forests on the west coast of America and if an adequate discriminant could be found between *P. radiata*, the hybrid complex, and *P. attenuata*, these environmental, or genetic effects, could be elucidated. One such discriminant is the composition of a minor fraction of the resin, responsible for the typical pine smell and known to chemists as the essential oil fraction. Thus *P. radiata* yields an essential oil containing only 25 per cent of a terpene called α-pinene, while *P. attenuata* oil is almost entirely α-pinene. However, with the low yield of essential oil, the large sample required, and the restricted chemical methods available it was found quite impracticable to examine a number of trees.

With the development of the separation technique known as vapour phase chromatography, it has become possible to analyse accurately a very small quantity of essential oil. Experiments were therefore initiated by the Dominion Laboratory to study the variation in the essential oil composition of *P. radiata* samples supplied by the staff of the Forest Research Institute. Several proven cases of hybridism were first examined by taking small tubes of bled resin from the trees and it was shown that the essential oil composition of these known hybrid trees was intermediate between that found for *P. attenuata* and *P. radiata*. In an attempt to discover the extent of hybridism in the plantations at Pigeon Valley, Nelson, and Ashley Forest, Canterbury, 100 samples were examined and the wide range of compositions found suggested that *P. radiata* could not be considered a pure species in the sense that *P. attenuata* is a pure species. To discover whether this range in composition was a feature of New Zealand *P. radiata* or an effect present in the native forests in America, 100 samples from Monterey, Anno Nuevo, and Cambria have been also examined. From these results it would appear that, with respect to essential oil composition, *P. radiata* is at least as hybridised in America as in New Zealand, and there is no evidence to suggest that an environmental effect is also present in New Zealand.

WOOD DENSITY MEASUREMENT

Forestry Research Institute expressed the need for an instrument which would rapidly and accurately determine the density of a wood sample taken from a living tree. Strength and pulping properties depend on this density which so far had to be measured by laboriously cutting and weighing large numbers of samples. This gave only average results across a number of growth rings. Ideally the change of density across a single ring should be measured.

An instrument has now been developed by the Institute of Nuclear Sciences and successfully tested which utilizes a very narrow beam of beta-radiation from a strontium-90 source. The beam is passed through a section of the wood which absorbs part of the rays – more for denser and less for lighter wood. After passing through the sample the beam falls on a scintillation counter.

While a small synchronous motor moves the sample through the beam of beta-rays, the strength of the emerging radiation is recorded by a pen-recorder. In this way the density of rings which are only $\frac{1}{16}$ in. apart can be reliably and automatically determined. The basic instrument is readily portable.

At present the same method is being used to investigate the possibility of measuring the density of teeth and parts of teeth. This work is associated with studies by the Health Department of the role of the trace element molybdenum in dental health.

Other inquiries have already been received in connection with the beta-densitometer, such as the possibility of early detection of rot in wooden poles.

RADIOISOTOPES AS TRACERS IN GEOPHYSICAL PROCESSES

The measurement of radioisotopes in the air, sea, and rainwater, and in biological samples has continued at the Institute of Nuclear Sciences. The isotopes measured are the fission products strontium-90, caesium-137 and barium-140, produced by nuclear explosions; and carbon-14 and radioactive hydrogen or tritium which are produced also by cosmic

rays in the atmosphere. The aim of this work is to use the radioactivity as a tracer to find out more about how fall-out particles, carbon dioxide, and water vapour are transported about the globe, and the rate at which the stratospheric store of these substances is depleted into the lower atmosphere, and thence into the oceans and other biological environments.

It has not been possible to take samples directly in the stratosphere, but the transfer of activity into the lower atmosphere can be shown by its appearance in surface water and air. Fission product measurements have shown the arrival of debris from the 1956 United States Pacific tests; the 1957 United Kingdom Australian and Pacific tests; and the 1958 United Kingdom and United States Pacific tests. Activity from megaton explosions has come to New Zealand via the stratosphere within a few months of the explosions. The longer term depletion of the stratosphere of accumulated radioactivity from all earlier tests is best shown by strontium-90 and carbon-14 measurements. Although the concentration of strontium-90 varies greatly from rain to rain, the monthly totals are more constant and show a springtime maximum perhaps twice the autumn minimum. The annual rate of deposition is now decreasing by about 25 per cent per year. The carbon-14 in surface air reached a maximum in mid 1960 and is now also decreasing. These measurements will allow the rate of exchange of carbon dioxide between stratosphere and lower atmosphere to be calculated. The carbon-14 in surface sea water appears to be reaching a maximum and this, together with results on deep ocean samples obtained for the oceanographers will allow the rate of exchange between surface air and surface oceans to be calculated.

So many requests for the measurement of carbon-14 in biological and geological samples are being received that it has been necessary this year to duplicate our equipment to deal exclusively with samples for Geological Survey. Tritium measurements can now be done reliably and routinely, and results for 1956–58 river-water samples have indicated a definite increase in the concentration of bomb-produced tritium. The methods developed for this project are also being used to help find out more about water movements in the geothermal regions.

A NEW NAVIGATION LIGHT

A novel type of navigation light has been developed by the Dominion Physical Laboratory for marking narrow channels. The usual method for doing this requires two lights – one behind the other in line with the channel. The new method has the advantage that it can be used where the configuration of the land in line with the channel will not permit the use of more than one light. There are additional advantages – the width of the channel can be defined by the light, systems of two or more neighbouring channels can be marked by the same light, and the navigator of a ship is relieved of having to make a judgment on when two lights appear vertically one above the other. (This judgment can be difficult to make on a dark night from a rolling ship.) The new light makes use of the well known device of projecting different colours in different directions (so that the navigator can tell from the colour of the light whether he is in the channel or to right or left of it), but it achieves an entirely new order of precision in doing so. For example, a person standing on the boundary between two sectors at a distance of half a mile from a trial model of the light received different colours

in his right and left eyes. The new system will be used in the Paremata-Porirua Harbour area where there are both a fishing fleet and a large number of pleasure craft. The first light has already been installed to mark the main inner channel. A second light should deal efficiently with the problems of a submerged rock in the outer approach channel and surrounding reefs.

STEADY-STATE GROUND TEMPERATURES UNDERNEATH KILN FLOORS

Trouble has been experienced in brick kilns situated on clay due to subsidence as the clay dries out. This has led to a short economic life for the kiln. The D.P.L. was approached to find a solution to this problem. It has been shown that putting a layer of insulation beneath the kiln would be uneconomic due to the excessive thickness required. However, it was shown that a comparatively thin layer of insulation overlying a thin layer of high conductivity – such as steel reinforcing mesh in gravel – can be as effective as a thick layer of insulation. This is because the conducting layer takes a major proportion of the heat out to the ground surface at the sides of the kiln. A further deduction based on theoretical and model work was that if the insulating layer is made thinner at the edges the effective insulation is actually better. The model work to solve the unsteady case has been handed to the Pottery and Ceramics Research Association with one of D.P.L.'s staff acting as adviser. It is confidently expected that the application of these theoretical studies to the design of new kilns will lead to a greatly increased economic life.

WHEAT RESEARCH INSTITUTE

Substantial loss to Canterbury wheatgrowers and the country was avoided during the 1961 wheat harvest through an emergency wheat-testing service provided by the Wheat Research Institute. Warm moist weather during the early harvest period caused germination to begin in most Canterbury wheat crops while the grain was still in the ear. In a few crops this went on until advanced sprouting was plainly evident and the wheat became totally unfit for milling into flour. In most crops, however, the visible evidence of sprouting was enough to raise doubts in the mind of the miller without being clear enough to give him a reliable criterion for rejection or acceptance for milling.

Anticipating that sooner or later this sort of situation would arise the Institute had over recent years taken opportunities to study various quality tests, one of which was the Hagberg method for predicting the effect of sprouting on bread quality from tests on small samples of grain. Experience with this test indicated that it gave a very satisfactory prediction and lent support to the hope that a rate of testing could be achieved that would avoid a slowing down of the handling of the crop. A testing service was set up immediately the millers asked for it.

Grain merchants collected samples from farmers' crops and had them tested, and then submitted the test result and the samples to the millers.

Surveys of all the test results from time to time gave an overall indication of the incidence of sprouting and of the average test results to be expected if the worst affected lines were rejected. Against this as a background millers accepted many lines of sprouted wheat that they would otherwise have rejected, and a much higher proportion of the crop was bought for milling than would otherwise have been the case.

BIOCHEMICAL STUDIES OF FATS

Detailed studies carried out by the Fats Research Laboratory with the Nutrition Research Unit of the Medical Research Council have shown that the beneficial effects of corn oil in lowering serum cholesterol in rats is accompanied by an elevation in cholesterol levels in the tissues and organs including the arteries and heart, thereby complicating the control of cholesterol metabolism in heart disease.

Preliminary work with the Department of Agriculture has been commenced to test the effect of anti-oxidants and fats on chicks with a view to studying cholesterol metabolism and to improving poultry rations by the inclusion of inedible tallows.

Examination of liver lipids from sheep dosed with sporidesmin in connection with facial eczema experiments at the Ruakura Animal Research Station has revealed that these lipids after two days increase in amount and change from a brittle to a waxy texture, thereby affording an early indication of the biochemical changes associated with the disease. As the phospholipid content remains at the same level the changes in texture of the lipid must be associated with the non-phospholipid fraction, which is being further investigated.

NEW ZEALAND SEED OILS

Investigations are in progress to determine the fatty acid composition of seed oils with a view to possible pharmaceutical or industrial utilisation as well as to supplementing morphological data in the classification of plants. Of special interest in this connection are the seed oils of Agavaceae represented by five Cordyline and two Phormium species which are shown to be similar in containing large amounts (74–87 per cent) of linoleic acid. Palm-seed oils elsewhere have been found to be distinct from other seed oils in containing large amounts (17–52 per cent) of lauric acid with minor amounts of linoleic. The seed oil of the indigenous palm *Rhopalostylis sapida,* however, provides a notable exception with 3 per cent lauric and 40 per cent linoleic acid. On the other hand, amongst the dicotyledons kernel oil of the indigenous black maire *Olea cunninghamii* was shown to be remarkably similar to that of the European olive (*O. europea*) with its characteristic high content of oleic acid.

INDUSTRIAL UTILISATION OF FATS

Further progress in determining the fatty acid composition of New Zealand tall oil has been retarded because the isomeric linoleic acids formed under the alkaline conditions of the pulping process cannot be determined quantitatively by conventional methods of analysis. However, background work involving the preparation of isomeric linoleic acids followed by studies of their gas-liquid chromatographic behaviour is anticipated to assist in the elucidation of the composition of tall-oil fatty acids.

Investigations on the subcutaneous fats of oxen and sheep show that these fats, compared with perinephric fat from which edible tallows are prepared, are characterised by lower melting points. The subcutaneous fat from oxen has considerable stability against atmospheric oxidation and a high ratio of palmitic to stearic acid, making it a valuable material for the soap, margarine, and stearic acid industries.

SURVEY OF CURRENTS IN MCMURDO SOUND

One of the major Antarctic problems is the definition of the heat budget of the Antarctic Continent. It is of fundamental importance to studies of the continent's climatic history and its affect on world climates to trace the movement of heat across its boundaries. A large number of people are engaged on different aspects of this problem for heat may be transported across the Antarctic margin by moving air or water or by ice. The location of McMurdo Sound permits the measurement of one of these means. Direct and indirect methods of measuring the water movements can be applied in the limited area of the sound.

A team from New Zealand Oceanographic Institute has spent several months at Scott Base and on HMNZS *Endeavour* this summer season, their major task being to carry out a survey of the currents and water characteristics in the Sound. Several methods were used. The temperature and salinity distributions off the sound entrance were mapped to provide information on the density-driven currents. At two sites near Cape Armitage, holes were cut in the ice and current meters operated through these to give a profile of measurements from the surface down to near bottom in 500 metres. On a number of occasions measurements were made each 20 minutes for several days. Electrodes were placed in the water and the e.m.f. induced between them by the moving sea water was recorded. Current meter stations were also occupied from *Endeavour* at various positions along the ice front in McMurdo Sound.

It was found that there was a residual drift from west to east past Cape Armitage of approximately half a knot. This flow was stronger at depth than at the surface. In McMurdo Sound a similar though less clear situation was revealed with flow at depth towards the Ice Barrier from the Ross Sea and less strong and sometimes northward currents at the surface. The results show that at least in the summer there is a definite movement of water towards the Antarctic Ice Shelf. Previous results obtained in the winter show a similar movement. This implies that heat is being supplied to Antarctica by the ocean water in this area, and may explain the unusually thin ice shelf in the McMurdo area.

PENGUINS AND SKUAS IN ANTARCTICA

During the summer of 1960–61, biological field work was carried out in three distinct localities: Cape Royds; on Ross Island, Cape Hallett; and Cape Adare.

At all three localities the nature of the work was the same, e.g., general population studies of breeding colonies of penguins and skuas. However, the problems affecting the stability and maintenance of the wildlife populations in these three localities differ considerably because of the secondary effects of human habitation in the areas under discussion. In one locality – Cape Hallett – the wildlife is adjusting itself to permanent human occupation and increasing encroachment because of the continuing expansion of Hallett Station. At Cape Royds the penguins are subjected to periods of quiescence frequently interrupted by "tourist" trips, while at Cape Adare the colonies of skuas and penguins are left without interference from one year to the next.

If the presence of humans is detrimental to the wildlife, a study of the above three rookeries and skuaries will show how and why, and also probably find the answers that ensure that no permanent damage is done to the indigenous fauna.

In evaluating the effects of human encroachment at Cape Royds and Cape Hallett, no "yardstick" was available as both had been subjected to outside influences for two or three seasons before these general conservational and breeding studies were commenced. To obtain the fundamental picture of a skuary or rookery it was necessary to assess one that had not been interefered with, and this summer the opportunity occurred to spend three weeks at Cape Adare, an area which has not been visited since the site was occupied by Scott's northern party in 1911.

Cape Adare was a fortunate windfall in two respects. Firstly, Murray Levick, the biologist of the 1911 wintering party, carried out a full study of the Adare rookery and assessed its population. This summer, the population was reassessed and this 50-year interval in an unmolested rookery will give unique data on the natural stability of the species. Secondly, it enabled us to assess and place in perspective the natural hazards and mortality factors, so ensuring that natural hazards will not be attributed to human domicile when evaluating Cape Royds and Cape Hallett.

At Cape Royds the work carried out this summer was a continuation of the studies initiated during 1959–60 by Young and Taylor. These studies had a close parallel to those done at Cape Hallett the same season, but their added value lay in the fact that the populations being studied were considerably smaller and were also subjected to more frequent environmental fluctuations, such as are caused by intermittent tourists' visits. Continued observation this summer was required to round off the picture.

At Cape Hallett, along with the general population studies, various specific projects were undertaken which will considerably add to the general knowledge of these birds.

Other projects included a full natural history (based on three seasons' observations) of the South Polar skua (*C. S. maccormicki*) in addition to lesser studies of emperor penguins, snow petrels and Weddell seals.

From the social point of view, the presence of a biologist at Cape Hallett was invaluable in instilling into the Naval personnel an interest in and appreciation of the necessity not to disturb the wildlife. This side has been so successful that outgoing Deep Freeze personnel enthusiastically indoctrinate their successors in non-interference with the birds. Also, though several biologists were working at Hallett on individual programmes, the degree of interdependence and consequent cooperation was conspicuous, one United States project – a physiological study – definitely benefiting because of the surgical ability of the New Zealand medical officer who assisted with the summer biology. This cooperation between the New Zealand and United States biology programmes was most actively pursued in relation to the bird banding project of the United States Antarctic Research Programme.

INFORMATION BUREAU

The Information Bureau is responsible for the editing and publishing of departmental publications and for the maintenance of the Central Library, the Technical Information Section, the Photographic and Photocopy Section, and for Publicity and Public Relations.

Three volumes of the three new journals (which replaced the *New Zealand Journal of Science and Technology*) have now been published.

Of these the *New Zealand Journal of Agricultural Research* is published in alternate months while the *New Zealand Journal of Science* and the *New Zealand Journal of Geology and Geophysics* are published quarterly.

During the year the Bureau has also published 24 bulletins and other publications on behalf of the Department.

The Central Library provides reference facilities for departmental officers, arranges book ordering for branches of the Department and generally acts as a coordinating centre for branch libraries. It also assists these libraries in training personnel and in improving library standards.

The Technical Information Section dealt with some 600 important inquiries during the year. The Technical Information Officer has kept in close touch with scientific officers and with the Scientific Liaison Offices. In his capacity of New Zealand Liaison Officer for the European Productivity Agency he has contributed to the Agency's publication *European Technical Digests* articles on New Zealand research and industrial development which have attracted several inquiries from European countries. He also supplied all of the abstracts and articles published during the year in the *Industrial Bulletin,* issued jointly by this Department and the Department of Industries and Commerce.

The Photographic Section has assisted various branches with specialised photographic work such as aerial and underwater photography.

During the year the Publicity and Public Relations Section prepared 40 press releases and articles relating to work of the Department and arranged for talks to the Library School, local secondary schools, vocational guidance officers, and rotary clubs. This Section has also initiated the preparation of branch handbooks, the first of which was published during the year.

CONCLUSION

The Department has continued to receive generous cooperation from other State Departments, the Cawthron Institute and the universities, overseas scientific organisations, and from both farming and manufacturing interests. The good relations that have prevailed have been much appreciated and have greatly assisted the promotion of the Department's objectives.

In conclusion, I would thank the staff of the Department for their help and cooperation during the year, and also express my personal indebtedness to the Council of Scientific and Industrial Research and its advisory committees for the assistance they have generously rendered on all occasions.

W. M. Hamilton, Secretary.

BRANCHES

ANIMAL ECOLOGY DIVISION

Director: Dr K. Wodzicki

PROJECTS

Mammals

Reproduction of Rabbits—Seasonal and geographic variations in productivity of rabbit populations.

Parasites of Rabbits—Factors controlling distribution and abundance of parasites and their role in rabbit mortality.

General Ecology of Rabbits—Behaviour of rabbits and factors determining their density in a 21-acre enclosure in the Wairarapa.

Testing of Research Techniques—Age determination and census techniques.

Application of Research Techniques to Problems of Rabbit Control—Trials of effectiveness of night shooting (with Applied Mathematics Laboratory).

Influence of Population Density on the Adrenal and Body Weights of Rabbits—(With Applied Mathematics Laboratory).

Cats, Rats, and Birds on Little Barrier Island and their ecological inter-relationships.

Ecology of Mustelids (Weasel, Stoat, and Wild Ferret) to elucidate problems faced by National Parks and game authorities.

Ungulates (Deer, chamois, thar, pigs, etc.)—Changes in distribution and abundance (with New Zealand Forest Service).

Birds

Basic studies on ecology of rooks, gannets, muttonbirds, blackbirds and effects of birds in controlling insects in exotic forests.

General Ecology of Specific Areas

Western Taupo—Effect of land development on the distribution and abundance of birds and mammals.

Motunau Island—Effects on vegetation and bird life resulting from the removal of rabbits (with Botany Division).

Campbell Island—Survey of introduced and native mammals (with Massey College and Botany Division).

PUBLICATIONS

Parasites of the European Rabbit, *Oryctolagus cuniculus* (L.), on some Subantarctic Islands. *N.Z. J. Sci.* *3*:258–73. 1960. P. C. Bull.

Populations of Tits and Goldcrests and their Food Supply in Pine Plantations. Ibid. *102*: 163–208. 1960. John A. Gibb. (*)

Road Mortality of the Hedgehog (*Erinaceus europaeus L.*) in New Zealand *Proc. zool. Soc. Lond. 134* (3): 505–8. 1960. R. Brockie.

Studies at an Adelie Penguin Rookery (in Polish). *Zool. Rev. Przegl. Zool. IV* (4): 303–6. 1961. R. H. Taylor.

Bird Populations. Chapter in *Biology and Comparative Physiology of Birds*, Vol. II. 1961. Ed. A. J. Marshall, Academic Press, New York. John A Gibb. (*)

(*) Work originally carried out in Edward Grey Institute, Oxford.

ANTARCTIC DIVISION

Superintendent: Mr G. W. Markham

PROJECTS

Scott Base—Scientific programme in aurora, ionosphere, geomagnetism, meteorology, and seismology.

Participating organisations: Geophysics Division and Dominion Physical Laboratory, of D.S.I.R., and the New Zealand Meteorological Service.

Hallett Station (Joint United States/New Zealand Station)—Scientific programme in aurora, ionosphere, geomagnetism, and seismology.

Participating organisations: Geophysics Division and Dominion Physical Laboratory, D.S.I.R.

Geological and Survey Mapping of the Ross Dependency—Survey of Victoria Land between Barne Inlet and Shackelton Inlet, 5,000 square miles.

Participating organisations: New Zealand Geological Survey and Department of Lands and Survey.

Oceanographical Projects—(1) Investigation of the currents and hydrology in McMurdo Sound; (2) Hydrological and magnetic surveys in the western Ross Sea; (3) Hydrological, magnetic, and biological surveys between New Zealand and Antarctica on HMNZS *Endeavour,* USS *Wilhoite,* and USS *Edisto.*

Participating organisations: Geophysics Division and New Zealand Oceanographic Institute, D.S.I.R.

Huts Restoration—Restoration of Scott's hut at Cape Evans and Shackelton's hut at Cape Royds.

Participating organisations: Antarctic Division, D.S.I.R., and New Zealand Antarctic Society.

Biological Investigations—Studies of Adelie penguins, skuas, seals, etc., at Cape Royds, Cape Hallett, and Cape Adare.

Participating organisation: Dominion Museum.

Non-government Project—The Victoria University of Wellington Antarctic Expedition in the Koettlitz Glacier area. Antarctic Division responsible for logistics and operational control.

APPLIED MATHEMATICS LABORATORY

Director: Dr R. M. Williams

PROJECTS

Agricultural Projects: Sampling methods for soil survey; aphid studies; development in methods of analysis in plant therapeutant work; natural selection of short-rotation ryegrass; inheritance of quantitative characters in ryegrass; development of methods of analysing growth curves of grass and application to effects of interspecific competition, etc.; analysis of grazing trials; distribution of root rot in hops; lactation curves of dairy cows. Genetic studies include heterosis in quantitative inheritance; separation of epistatic from additive and dominance variation; expression

of gametic distribution in terms of linkage parameters; inclusion of linkage in theory of epistasis in quantitative inheritance; and general theory of continuous variation.

Industrial and Operational Research Projects: Queueing studies for civil aviation communication network and for industry; preservation of timber; aircraft baggage and mail loadings; sampling inspection schemes for various industries.

Mathematical Physics: Moisture movement in clay; work on geothermal project including prediction of subsurface temperatures; dynamics of steam and water flow out of pipes; motion of fluid between sloping boundaries; non-linear theory of convection in tubes; effect of draw off in a geothermal field.

Miscellaneous: Sequential sampling in geology; analysis of ironsand surveys; relation of dental caries to soil types; sample survey for classification of banking deposits; tests on effectiveness of night shooting in rabbit control; work for the Endocrinology Department of Medical Research Council; traffic studies for road design; studies on absconding prisoners for Justice Department; organisation of technical work on electronic computer for other departments; educational study on military trainees and on promotion by age of school children.

Basic Mathematical Studies: Birth and death processes; properties of Markoff chains; power functions in analysis of variance; experimental design; properties of partial differential equations.

PUBLICATIONS

Mathematical Analysis of Growth Curves Replicated in Time. *N.Z. J. agric. Res.* 2:297–305. 1959. A. C. Glenday.

The Effects of Frequency and Intensity of Grazing on the Genotype Structure of a Ryegrass Population. Ibid. *3*:442–53. 1960. A. C. Glenday (with R. W. Brougham and S. O. Fejer).

The Separation of Epistatic from Additive and Dominance Variation in Generation Means, II. *Genetics, 31*:133–46. 1960. B. I. Hayman.

Maximum Likelihood Estimation of Genetic Components of Variation. *Biometrics.* 16: 369–81. 1960. B. I. Hayman.

Methods of Analysis and the Influence of Fleece Characters on Unit Area Wool Production of Romney Lambs, *Aust. J. agric. Res. 11*:851–70. 1960. A. E. Henderson and B. I. Hayman.

Mathematics: Useless or Worse? *Sci. Rec.,* pp. 41–3. 1960. A. McNabb and R. M. Williams.

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The Covariance Analysis of Time Replicated Data. *N.Z. J. Sci. 3*:649–57. 1960. P. Whittle and H. S. Roberts.

An Appendix on Statistical Method Applied to Bivariate Analyses of *Rzehakina* Cushman. *N.Z. J. Geol. Geophys. 4*:42–3. 1961. R. M. Williams.

Instability of a Viscous Liquid of Variable Density in a Vertical Hele-Shaw Cell. *J. Fl. Mech. 7*:501–15. 1960. R. A. Wooding.

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AUCKLAND INDUSTRIAL DEVELOPMENT LABORATORIES

Director: Mr J. B. Brooke

PROJECTS

Medical Instrumentation Group—Calibration of and modifications to cuvette oximeter for measurement of blood oxygen and dye concentration; construction of ear piece for recording of dye concentration curves; construction of foetal pulse recording unit to discriminate between genuine pulses and artifacts; further modifications to heart-lung machine including the construction of two new venous reservoirs; construction of pressure cuff unit for plethysmograph; design and development of twin syringe rate injector; development of haemoglobinometer transistor amplifier.

Fuel Group—Wood waste combustion; preliminary survey of types of boilers in Auckland area; efficiency of operation of four boiler plants; investigation of several industrial drying processes; metering large water flows; examination of coal and ash samples.

Foundry Group and General Metallurgical Section—Investigation of the foundry properties of New Zealand cokes; experiments on effect of oxygen enrichment of cupola blast and oxygen injection of cupola metal; investigations into production of small quantities of steel by alumino-thermic method, using local ironsands and scrap aluminium turnings as base materials; investigation of metallurgical aspects of automobile leaf spring manufacture; and assistance with industrial corrosion problems.

Design Section—Medical: Twin syringe infusion unit for accurate and extremely low infusion rates; high-speed dual-pressure cuff inflation unit; two stainless steel flange-type venous reservoirs; dilators for surgical use; and improvements to artificial heart-lung machine. *General:* Further investigations into "bulging" of shotgun barrels and propagation of pressure waves; further investigations into water circulation and skimming efficiency of school learner swimming pools; continuation of swimming-pool paint durability experiment; production model of facial eczema spore collector; and tidal artificial sunlight unit for marine biological research. *Industrial:* Automatic flour sifting device for biscuit dough laminating machine; survey of Auckland spring manufacturing industry and compilation of spring design data and specification for automobile leaf springs; design of magazine feed in bottle and ampoule filling machine; wire resistance and shearing test unit.

Physics Section—Air-pollution investigations including assistance to the Auckland Air Pollution Research Committee in establishing air-sampling programmes; examination of particulate contents of industrial exhausts to assist in overcoming nuisance problems and to check on efficiency of filtering plant; miscellaneous measurements of length and angle, vibrations and other physical quantities; investigation into the mechanism of the freezing of pears and development of theory to explain the observed experimental results.

Precision Workshop—Manufacture of: spore collectors for facial eczema programme; pulsator bobbin for experimental milking machine; ammunition gauges for Army inspection; dough laminating machine; shrinkage comparator for wood samples; tensometer for glue testing in the production of laminated wood arches; twin syringe infusion

appliance; cuff inflation machine; venous reservoirs for heart-lung machine; crushing rolls for production of serrated knives; cast iron sampling machine; wire resistance and shearing jig for quality control of insulated cable; underwater light source for marine biological research; dust elutriator and venturi meter for fuel utilisation work; foetal heart rate recorder; whole blood oximeter; electrodes for cardiac pacemaker; protozoa counter; cell for measurement of cardiac efficiency by dye concentration curves; multiple cells for ultra-centrifuge.

Industrial Liaison and Information—Symposium on heat treatment in industry; survey of electroplating industry, Auckland area; assistance with formation of Australasian Corrosion Association, Auckland Branch, organisation of inaugural school science exhibition; film reviews for National Film Unit; evaluation of power-saw benches for use in schools; lectures to various industrial groups, Rotary clubs, commercial groups, and educational authorities on science in industry and science in the community.

PUBLICATIONS

An Improved Recording Oximeter. *Electron. Engng. 20*:296–300. 1960. A. W. Melville, D. H. Smith, and J. B. Cornwall.
Science in Industry. *N.Z. Mfr.*:81–5 and 105–7. 1960. J. B. Brooke.
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A Rapid Counter for Small Articles in Suspension. *J. Sci. Instrum. 37 (11)*:414–7. 1960. J. B. Cornwall.

BOTANY DIVISION

Director: Dr E. J. Godley

PROJECTS

Herbarium—Maintenance and expansion of indigenous, adventive, and cultivated plants sections of herbarium; accessions of specimens of indigenous plants from Egmont, Nelson Lakes, Mt. Cook, and Campbell Island; and collection and distribution of seeds of indigenous plants.

Botanic Garden—Development of garden continued at Lincoln with provision of more facilities and land; increased amount of plant material under observation, and additional species added to the permanent growing reference collection of plants.

Taxonomic Studies—Vol. I of the revised *Manual of New Zealand Flora* is completed; work has commenced on Vol. II (Monocotyledons), and the material is being assembled for Vol. III (Adventive plants); and revision of indigenous alpine species of *Ranunculus* is in progress.

Vegetation Studies—Vegetation surveys of Nelson Lakes, Mt. Cook, Egmont, Tongariro, and Arthur's Pass National Park in progress; aquatic vegetation, and bog and swamp survey continued; and Campbell Island completed.

Chromosome Studies—Further contribution to the chromosome atlas of indigenous plants published.

Quaternary History—Pollen and macrofossil analyses of Chile, Subantarctic, and Ruahine peats; pollen morphology of indigenous Callitrichaceae; pollen analyses for Department of Agriculture; and expansion of permanent reference collection of pollens.

PUBLICATIONS

Forest Vegetation of the Inner Islands of the Hauraki Gulf. *Proc. N.Z. ecol. Soc. 7*:29–33. 1960. I. A. E. Atkinson.

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Breeding Systems in New Zealand Grasses-3, *Festuceae, Aveneae* and *Agrostideae*. Ibid. *3*:728–33. 1960. H. E. Connor.

Note on Proliferation in *Rubus parvus* Buchanan. *N.Z. J. Sci. 3*:396–8. 1960. H. E. Connor and E. D. Penny.

Poisonous Plants in New Zealand. *N.Z. Dept. Agric. Bull.* 356. Rev. Ed. 1960. H. E. Connor.

Some Aspects of the Botany of Tussock Grasslands. *Proc. 10th Lincoln College Fmrs. Conf.*:78–81. 1960. H. E. Connor.

Variations in Leaf Anatomy in *Festuca novae-zelandiae* (Hack.) Cockayne, and *F. matthewsii* (Hack.) Cheeseman. *N.Z. J. Sci. 3*:468–509, 1960. H. E. Connor.

Comparative Physiology of Ecological Races in *Mimulus*. *Proc. N.Z. ecol. Soc. 7*:17–19. 1960. F. J. F. Fisher.

A Discussion of Leaf Morphogenesis in *Ranunculus hirtus*. *N.Z. J. Sci. 3*:685–93. 1960. F. J. F. Fisher.

Leaf Shape in *Ranunculus insignis*. Ibid. *3*:676–84. 1960. F. J. F. Fisher.

The Botany of Southern Chile in Relation to New Zealand and the Subantarctic. *Proc. roy. Soc. B152*:457–75. 1960. E. J. Godley.

A Note on Archibald Menzies. *Proc. roy. Soc. N.Z. 88*:63–4. 1960. E. J. Godley.

Contributions to a Chromosome Atlas of the New Zealand Flora-4, Miscellaneous Families. *N.Z. J. Sci. 3*:432–40. 1960. J. B. Hair and E. J. Beuzenberg.

High Polyploidy in a New Zealand *Poa*. *Nature Lond. 189*:160. 1960. J. B. Hair and E. J. Beuzenberg.

Identification of Thistles and Thistle-like Weeds. *13th N.Z. Weed Control Conf.*:16–22. 1960. A. J. Healy.

Three Waterweeds of the Family *Hydrocharitaceae* in New Zealand. *N.Z. J. Sci. 3*:382–95. 1960. R. Mason.

Studies in Pollen Morphology-1. The New Zealand Species of *Hydrocotyle* Linn. Ibid. *3*:51–60. 1960. N. T. Moar.

Studies in Pollen Morphology-2, The Pollen of the New Zealand and of two Australian Species of *Callitriche* L. Ibid. *3*:415–21. 1960. N. T. Moar.

Some Botanical Features of Wellington. In "Science in Wellington." *Roy. Soc. N.Z.*, pp. 14–16. 1960. L. B. Moore.

The Subalpine Scrub of the Hokitika Catchment, Westland. *Trans. roy. Soc. N.Z. 88*:47–61. 1960. P. Wardle.

CROP RESEARCH DIVISION

Director: Dr L. Corkill

FIELD-CROP PROJECTS

Wheat Breeding and Genetics—General-purpose wheats with higher baking quality; early-maturing rust-resistant wheats for the North Island; development of high-quality high-yielding variety to replace Hilgendorf; commercial varieties resistant to mildew and yellow dwarf virus. Inheritance studies of quantitative characters.

Oats—Development of commercial varieties resistant to lodging and to rusts and yellow-dwarf virus.

Barley—Introduction of overseas varieties.

Ryecorn—Maintenance breeding of C.R.D. Ryecorn.

Potato Breeding—Resistance to blight (*Phytophthora infestans*), scab, and pink rot (*P. erythroseptica*); resistance to viruses A, S, X, Y, and leafroll; and improved agronomic characters.

Potato Virus Diseases—Study of natural spread and control, strains, testing methods, resistance, aphid vectors; and selection, and maintenance of virus-free stocks.

Potato Blight—Study of strains, resistance and gene action.

Agronomy—Effect of irrigation and other practices upon yields.

Brassica Breeding and Genetics—Breeding for resistance of rape to aphids, of swedes to dry rot and clubroot, and of turnips to cauliflower mosaic and clubroot. Transfer of characters between *B. rapa* and *B. napus*.

Lucerne Breeding and Agronomy—Breeding for winter production, creeping rooted habit coupled with high productivity, and resistance to eelworm; growth rates of varieties; effects of grazing management and plant density on winter production; and soil moisture supplies.

Lupin Breeding—Production of sweet forms with high forage yields and non-shattering pods.

Linseed—Introduction and testing of varieties.

VEGETABLE PROJECTS

Breeding and Selection—Clubroot resistance in vegetable brassicas; selection for uniformity in spring cabbage and cauliflower; white-rot resistance in onions; type selection in Pukekohe Longkeeper onion; rust resistance in pole beans; mosaic immunity in wilt-resistant peas; spotted wilt resistance in outdoor tomatoes; mosaic and leaf-mould resistance in glasshouse tomatoes.

Variety Trials—Evaluation of five- and six-month winter cauliflower.

Other Projects—Investigation on susceptibility to mosaic in cauliflower; vegetable propagation methods in brassicas; breeding systems in vegetable brassicas; maintenance and comparative studies of kumaras from New Zealand, South America, and Pacific area.

BIOCHEMISTRY AND PHYSIOLOGY PROJECTS

Chemical Composition—Kumara, brassica, and vegetable varieties; maize; silage.

Nitrogen Metabolism—Nitrogen fixation; urea metabolism by excised roots; aphid resistance; proline metabolism in reproduction; protein development in maturing wheat.

Enzyme Studies—Enzymes and blight resistance in potato seedlings.

Growth Physiology—Nutritional requirements of excised root cultures; mineral uptake of varieties and species; hormonal regulation of seed production.

NUCLEUS SEED PRODUCTION

Pure seed of 26 field-crop varieties and nine vegetable varieties has been grown for increase and distribution under the seed certification scheme and the vegetable seed approval scheme.

PUBLICATIONS

Control of potato viruses in the Pukekohe area. *N.Z. Commerc. Grower 16 (2)*:3–8. C. M. Driver.
Potato varieties in the Auckland area. Ibid. *16 (3)*:5–7. C. M. Driver.
Tahi and Rua – Two new potato varieties. *N.Z. J. Agric. 101 (4)*:218–20. C. M. Driver.
Swede (*Brassica napus*) seeds with split cotyledons. I. The distribution of split cotyledons on plants. *Ann. Bot.* n.s. *24 (93)*:48–51. T. P. Palmer.
Aphis resistant rape. *N.Z. J. Agric. 101 (4)*:375–6. T. P. Palmer.
Winter growth of lucerne (*Medicago sativa*). II. Genetic variations in a population of Hunter River Lucerne. *N.Z. J. agric. Res. 3 (4)*:641–6. T. P. Palmer.
Control of motley dwarf virus disease in carrots. *N.Z. Commerc. Grower. 16 (2)*:13–14. H. C. Smith, H. J. Giesen, and J. D. Allen.
Factors affecting the abscission of reproductive organs in yellow lupins. III. Endogenous growth substances in virus-infected and healthy plants and their effect on abscission. *J. Exp. Bot. 10 (30)*:367–76. 1959. R. F. M. van Steveninck.
French-bean rust (*Uromyces appendiculatus*). Studies on resistance and determination of rust races present in New Zealand. *N.Z. agric. Res. 3 (2)*:358–63. D. E. Yen and R. M. Brien.
The sweet potato in the Pacific: The propagation of the plant in relation to its distribution. *J. Polynesian Soc. 69 (4)*:368–75. D. E. Yen.
Wilt-resistant Onward peas. *N.Z. J. Agric. 101 (6)*:565–6. D. E. Yen and R. J. Casey.
Crop Research Division Handbook. *N.Z. Dep. sci. industr. Res. Inf. Ser. 29.*

DOMINION LABORATORY

Director: Mr I. K. Walker

PROJECTS

Cement and Concrete—Accelerated methods of determining strength of concrete; aeration in concrete set; minerals formed in hydrated cement; dairy factory floors; failures of concrete pipes.

Chemical Engineering—Pulping of *Pinus radiata* chips; mass flow enthalpy in Wairakei steam; producer gas; grit arrestor; binderless briquetting of coal and use of indigenous binders.

Coal—Resampling, and revision of analyses; mine gases; limestones as inhibitors of coal-dust explosions; moisture relationships; Nevis oil shales.

Food and Drug Section—Titahi Bay pollution; food additives; DDT in milk; ascorbic acid in fruit; sodium-potassium ratio in milk ash.

Inorganic Chemistry—Geochemical prospecting at Wairakei; investigations of water solutions at high T and P; aqueous chemistry of sulphur; geothermal sampling methods; geochemical investigations; survey of limestones.

Metallurgy—Bore casing fractures; geothermal corrosion; copper and copper-alloy corrosion; ironsands; steel ties for wool bales.

Organic Chemistry—Aramite residues on apples; systemic organic phosphorous residues in fruit; diphenylamine and santoquin in control of apple scald; apple tree nutrition investigated from the inorganic constituents of the leaves; infrared identification of textile fibres; toxicological and forensic investigations.

Paint and Petroleum—Yellowing of *P. radiata* by sunlight; "natural finishes" for exterior woodwork; painting of tawa weatherboard; painting finishes for concrete work; fuel oils for pentachlorophenol wood preservative; float test for bitumen.

Physical Chemistry—Toxic ingredients in paints; germanium in flue dusts; dust explosions in sulphur fertilisers; matrix effects in emission spectrography; influence of hydration on X-ray diffraction of minerals.

Wood Chemistry—Chemistry of *biformene* and *colensone oxide; P. radiata* as a source of α cellulose pulp; hybridism in *P. radiata*; multiple cell compensation techniques in infrared spectrography.

Director's Section—Spontaneous ignition of spent brewing grains; kinetics of reaction between pie wool and oxygen; surface cooling in spontaneous ignition; heat output of bacterial cells.

District Laboratories—Physical and chemical properties of Christchurch smoke; micro-methods for estimation of sulphur dioxide and sulphate; fermentation gases from muds and *ulva* (sea lettuce); pollution in harbours and estuaries; food investigations affecting public health.

PUBLICATIONS

Possible Ironsands for an Iron and Steel Industry in New Zealand. *Proc. Min. Conf. Dunedin, New Zealand 1959, Pap. No. 128*:1–10. 1960. D. S. Nicholson.

A Preliminary Investigation into the Production of Medium-weight Aggregate for Concrete. Ibid. *Pap. No. 129*:1–14. 1960. D. S. Nicholson.

Ilmenite Deposits in New Zealand. Ibid. *Pap. No. 134*:1–8. 1960. D. S. Nicholson.

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Metallurgical Coke from New Zealand Coals. Ibid. *Pap. No. 170*:1–20. 1960. W. G. Hughson.

New Zealand Oil Shale. Ibid. *Pap. No. 178*:1–21. 1960. J. O. Elphick.

Influence of Pressure on the Hammett Reaction Constant. *J. chem. Phys. 31*:176–7. 1959. A. J. Ellis, W. S. Fyfe, R. I. Rutherford, A. Fischer, and J. Vaughan.

The Spontaneous Ignition of Wool. 2. A New Process for Wool Removal from Sheepskin Pieces. *J. appl. Chem. 9*:608–15. 1959. M. S. Carrie, I. K. Walker, and W. J. Harrison.

Spontaneous Ignition of Wool. 3. Calorimetry of Slow Oxidation Reactions in Materials of Low Thermal Conductivity. Ibid. *10*:266–76. 1960. I. K. Walker and W. J. Harrison.

The Stereochemistry of Isophyllocladene. *Tetrahedron Letters No. 10*:21–2. 1959. P. K. Grant and R. Hodges.

The Effect of Pressure on the Ionization of Some Benzoic Acids. *J. chem. Soc.*:247–54. 1960. R. J. H. Clark and A. J. Ellis.

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Experimental Fluidized-bed Reduction of New Zealand Ironsands. *N.Z. J. Sci. 3*:74–92. 1960. W. Shannon, W. Kitt, and T. Marshall.

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Air Pollution and the Chemist. *J. N.Z. Inst. Chem. 24*:46–62. 1960. L. Wilkinson.

Analysis of Very Small Samples of New Zealand Coals. *Fuel, 39*:183–6. 1960. J. O. Elphick.

Ultraviolet Spectra of Water Solutions. *Nature, Lond. 186*:308. 1960. R. M. Golding.

Rapid Identification of Elastomers and their Additives. *J. appl. Chem. 10*:192–5. 1960. B. Cleverley and R. Herrmann.

Storage Trial on New Zealand Beef and Mutton Vacuum-dried in Fat. *Australia, Div. Food Preserv. Transp. Tech. Pap. No. 19.* 1960. A. R. Prater, N. W. Vere-Jones, and E. A. Roberts.

A Refinement in the Analysis of the Hydrogen Evolution Curves Obtained when Testing Duralumin for Susceptibility to Intercrystalline Corrosion. Ibid. *10*:138–9. 1960. G. J. Schafer.

Changes in the Infrared Spectra of Some N-methyl Aminoacid Hydrochloride Salts Using KBr Discs. *Chem. & Ind.*:964. 1960. C. C. Watson.

The Structure of Isophyllocladene. *Tetrahedron, 8*:261–5. 1960. P. K. Grant and R. Hodges.

Identification of Barbiturates from their Infrared Spectra *Analyst, 85*:582–7. 1960. B. Cleverley.

Mordenite Synthesis in a Natural Hydrothermal Solution. *Geochim. et cosmochim. Acta 19*:145–6. 1960. A. J. Ellis.

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Dilute Hydrochloric Acid by a Simple Ion Exchange Process. *Industr. engng Chem. 52*:909–14. 1960. A. M. Kennedy.

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The Geochemistry of Alkali Metal Ions in the Wairakei Hydrothermal System. *N.Z. J. Geol. Geophys. 3*:593–617. 1960. A. J. Ellis and S. H. Wilson.

Hydrogen Diffusion in Mild Steels. *Nature, Lond. 188*:399–400. 1960. P. K. Foster.

On the Role of the Oxygen Concentration Cell in Crevice Corrosion and Pitting. *J. electrochem. Soc. 107*:1002–4. 1960. G. J. Schafer, J. R. Gabriel, and P. K. Foster.

A Rapid Method of Determining the Regain of Scoured Wool After Machine Drying. *Text. J. Aust. 35*:932–4, 939. 1960. H. P. Rothbaum and N. W. Vere-Jones.

Structure of Ketomanoyl Oxide. *Chem. & Ind.*:1300. 1960. P. K. Grant and R. Hodges.

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Ultraviolet and Structural Studies of Polythionates. *J. chem. Phys. 33*:1666–8. 1960. R. M. Golding.

Infrared Identification of the N-Methyl Group in Substituted Amino Acid Hydrochlorides. *Spectrochim. Acta, 16*:1322–7. 1960. C. C. Watson.

DOMINION PHYSICAL LABORATORY

Director: Mr W. H. Ward

PROJECTS

Electron Microscope—Physiological effects of the removal of surface wax from white clover by weathering (in conjunction with Grasslands Division); investigation of normal cytology of spermiogenesis in cave weta; assistance with taxonomy of streptomycetes from New Zealand soils.

Optics—Theory of lens design; construction of numerous special optical systems.

Heat Transfer—Measurement of thermal conductivities; general advice on thermal insulation and heat problems; investigation into utilisation of solar energy for house heating and domestic hot-water supply; development of models of geothermal system.

Temperature—Testing and development of temperature-measuring instruments. Calibration of thermometers.

Plant Physics—Investigation of cell-wall growth relating observed mechanical properties of cell wall to its fine structure; physical basis of photosynthesis; application of electron spin resonance techniques to biological problems.

Engineering Seismology—Investigation of bearing-wall, frame, and mixed-type structures; examination of multi-storey yield and friction damping; maintenance of strong-motion earthquake recorders and buildings instrumented for earthquakes to get data on actual earthquake performance.

Fluid Mechanics—Measurements of the flow and pressure of liquids and gases; preliminary work on air gauging.

Radio Research—Use of a frequency standard in study of long-distance ionospheric propagation at very low frequencies; measurement of ionospheric winds; measurement of radio "whistlers" and similar phenomena; use of radar in study of auroral ionisation, in conjunction with a wide programme of auroral studies using visual photographic and spectroscopic methods; study of radio propagation through the auroral zone; study of the lower ionosphere using v.h.f. forward scatter.

Standards—Establishment of standards of physical measurement in length, mass, force, temperature, pressure, photometry, radiation, and air velocity; maintenance of standards of electrical quantities, and examination and calibration of substandards against the national standards; setting up of standards of reactance; development of methods of measuring electrical quantities at radio frequencies; maintenance of the standard-frequency radio transmissions.

General—Development of apparatus to study effect of wind on sea waves; tests (mainly electrical) to encourage improved quality in New Zealand commodities; advice on problems in acoustics, studies of transmission of sound in multiple-unit dwellings; calibration of microphones; application of automation to various industrial work.

PUBLICATIONS

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The Response of Growing Plants to a Uniform Daily Rotation. Ibid. *185*:775. 1960. R. L. Jones.

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Ionospheric Scattering of Satellite Transmissions. Ibid. *189*:906. 1961. J. Mawdsley and I. R. Richards.

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On the Mode Theory of Very Low Frequency Propagation in the Presence of a Transverse Magnetic Field *J. Res. Nat. Bur. Stand.* *64D*:265–7. 1960. D. D. Crombie.

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A Note on the Analysis of Seven Years Visual Observations of the Aurora from New Zealand and Campbell Island. Ibid. *16*:414–8. 1960. M. and M. N. Gadsden.

Colour Confusion Produced by Voluntary Fixation. *Optica Acta 7*:281–90. 1960. K. J. McCree.
Small-field Tritanopia and the Effects of Voluntary Fixation. Ibid. *7*:371. 1960. K. J. McCree.
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Field Aligned Ionization. Ibid. *65*:1828–30. 1960. J. Mawdsley.
New Ionospheric Radio Communication Techniques. *Radio Elect. Rev. 15 (11)*:23. 1961. *15 (12)*:24. 1961. J. Mawdsley.
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An Analogue Computer for the Determination of the Earthquake Response of Buildings in Bending and Shear Modes. Ibid. *2*:1181–94. 1960. K. M. Adams, R. A. Morris, and R. I. Skinner.

ENTOMOLOGY DIVISION

Director: Dr W. Cottier

PROJECTS

Pasture and Crop Insects—Biology, ecology, and natural enemies of army worms; origin and growth of populations of cabbage aphid on crucifers in Canterbury; chemical control of moth in maize; control of stem weevil in ryegrass; study of life and seasonal cycles, and of chemical control of white-fringed weevil; control of black beetle; search overseas for parasites of clover case-bearers; continuation of work on chemical control of grass grub and Oxycanus, alternative chemicals to DDT being investigated.

Orchard Insects—Search overseas for parasites of pear slug; examination of forecasting scheme for orchard pests in Nelson; further survey of insect pests of Cook Islands with emphasis on scale on citrus, and termites in coconuts; confirmation of importance of pine shelter belts in harbouring scale insects which attack apples.

Taxonomy—Biology and taxonomy of sand flies as preliminary to control measures; revision of scale insects of family Eriococcidae; maintenance and development of insect reference collection; taxonomy of larval Lepidoptera; systematics of Melolonthinae, including the larvae, and of Thynninae, aphids and scale insects in general.

Insect Surveys—Continuation of survey of pasture and crop insects; survey of natural enemies of economic scale insects.

Nematology—Investigation of nematodes in plants and soil in England as preliminary to study of nematodes of importance to agriculture in New Zealand.

Other Projects—Introduction of gall-forming flies as possible control for Mexican Devil weed; biological control of flies, San Jose scale, vegetable weevil, St John's Wort; fly control in Niue Island; control of Oak leaf miner by parasites; virus and bacterial control of insects; spermiogenesis of cave weta; control of biting flies on stock; maintaining of identification and advice service on control of insects.

PUBLICATIONS

Two New Pycnogonids from the Maldive Islands. *Ann. Mag. Nat. Hist. Ser. 13, vol. iii*:291–6. 1960. W. C. Clark.

The Oesophago-intestinal Junction in the Mononchidae (Enoplida, Nematoda). *Nematologica 5*:178–83. 1960. W. C. Clark.

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I. The Genera *Monochus* Bastian and *Prionchulus* Cobb. Ibid. *5*:199–214. 1960. W. C. Clark.

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Preliminary Assessment of Toxaphene, Strobane, and Thiodan for Control of Clover Case-bearers (Coleophora spp.) (Coleophoridae, Lepidoptera). *N.Z. J. agric. Res. 3*:617–22. 1960. J. M. Hoy.

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Sub-fossil Mites from the Hutt Valley. *Trans. roy. Soc. N.Z. 88*:575–6. 1960. G. W. Ramsay.

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*Journal published by Ivon Watkins Ltd., New Plymouth.

FATS RESEARCH LABORATORY

Director: Dr F. B. Shorland

PROJECTS

General Investigations on Animal Fats with Special Reference to Those of Meat and Butter—Isolation and identification of minor constituents; glyceride structure; fatty acid composition of different tissues at different stages of growth.

Fat Metabolism in Ruminants—Effect of the rumen on dietary unsaturated fatty acids, in relation to depot fats; use of labelled intermediates to determine the origin of minor constituents of milk and depot fats.

Nutritional Significance of Minor Constituents of Animal Fats—Aspects of general problem being studied in association with Medical Research Council include: (a) relationship between certain lipid constituents, cholesterol deposition, and atherosclerosis; (b) fate of branched-chain fatty acids in the body.

Nature of Phospholipids in Animal Products—Preparation of phospholipid fractions from meat and milk products to determine their composition and role in the keeping properties and quality.

Effect of Antioxidants in Relation to Dietary Fat Levels in the Nutrition of Poultry—Experiments in association with the Department of Agriculture to formulate high-energy rations utilising inedible tallow and provide information on cholesterol metabolism.

Development of New Techniques for the Investigation of Fats—Gas-liquid chromatography; application of infrared spectroscopy to analysis of phospholipids.

Investigations on Leaf Lipids with Special Reference to Pasture—Occurrence with significance of galactolipids and phospholipids.

Studies on Fungal Lipids—Fatty acid composition of *Pithomyces chartarum* and related species as part of the facial eczema programme.

Composition of Seed Oils from Indigenous Plants—Determination of possible pharmaceutical value; composition in relation to botanical classification.

Industrial Utilisation of Fats and Fatty Oils—Composition of tall oil and its potential utilisation; modification of animal fats to widen their usage; synthesis of triglycerides and related compounds. The production of detergents and emulsifying agents from local raw materials, particularly tallow.

PUBLICATIONS

The Component Fatty Acids of *Sporidesmium bakeri* Lipids. *Biochem. J.* *75*:274–8. 1960. L. Hartman, J. C. Hawke, I. M. Morice, and F. B. Shorland.

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The β Monoester Content of Commercial Monoglycerides after Prolonged Storage. *J. Sci. Fd. Agric.* *11*:191–4. 1960. L. Hartman.

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Acetone-soluble Lipids of Grasses and Other Forage Plants. II. General Observations on the Properties of the Lipids with Special Reference to the Yield of Fatty Acids. Ibid. *12*:39–43. 1961. F. B. Shorland.

The Fatty Acid Composition of the Depot Fats of the Kiwi *(Apteryx australis mantelli)*. Ibid. *12*:174–8. 1961. F. B. Shorland and J. Gass.

Chemical Composition of Animal Depot Fats, in "Biochemists' Handbook", published by E. and F. N. Spon Ltd., London, W.C. 2. pp. 691–701. 1961. F. B. Shorland.

Fatty Acid Composition and Other Characteristics of Subcutaneous Fat from New Zealand Oxen and Sheep. *N.Z. J. Sci. 4*:16–25. 1961. L. Hartman and F. B. Shorland.

FRUIT RESEARCH DIVISION

Director: Mr J. D. Atkinson

PROJECTS

Physiology—Elements present in xylem sap; entry of nutrients through leaves; mechanism of phloem transport; cell division factors and hormones present in young fruits; effects of leaf-fruit ratios on cell number in fruits; growth of plant tissues in sterile culture; utilisation of organic nitrogen compounds for growth of plant tissue; metabolism of ureides and urea in plants.

Orchard Practices—Field fertiliser trials and application of leaf analysis to orchard problems; use of grass and clover swards; use of hormones for increasing fruit set, prevention of fruit drop, thinning, and control of biennial bearing; methods of shaping apple trees.

Storage—Methods for controlling superficial scald, internal breakdown, bitter pit, and wilt; controlled atmosphere storage; effects of orchard factors on storage quality; methods for increasing cell number in apples.

Pomology—Testing new varieties of apple, apricot, citrus, chinese gooseberry, peach, and plum; long-term trials of stocks of apple, citrus, pear, and plum; formal descriptions of apples and plums.

Processing—Assessment of correct maturity for havesting canning pears; post-harvest ripening of canning peaches; preservation of citrus juice, and tree tomatoes.

Miscellaneous—With Plant Diseases Division, identification of fruit viruses; virus effects on tree growth and yield; indexing bud wood trees. Methods of controlling frost; bird scaring devices.

PUBLICATIONS

Biological Balance. *Proc. N.Z. Inst. agric. Sci.*:85–9. 1960. J. D. Atkinson.

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Striped Cracking in Kidd's Orange Red Apples. Ibid. *33*:72–73. 1960. E. E. Chamberlain, J. D. Atkinson, and J. A. Hunter.

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III. Characteristics of Sugar Uptake in Slices of Mature and Immature Storage Tissue. *Aust. J. biol. Sci. 13*:203–20. 1960. R. L. Bieleski.

IV. Effects of Inhibitors on Sugar Accumulation in Storage Tissue Slices. Ibid. *13*:221–31. 1960. R. L. Bieleski.

Grafting Passionfruit Vines. *N.Z. J. Agric. 101*:401, 403, 405. 1960. G. W. J. Blacker.
Incorporation of ^{14}C into the Protein of Particles Isolated from Plant Cells. *J. exp. Bot. 11*:151–66. 1960. J. F. Sutcliffe, E. G. Bollard, and F. C. Steward.
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Split Stone of Peaches in New Zealand. *Orchardist of N.Z. 33*:146–7. 1960. A. Farmer.
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Growth Requirements of Pome Fruit Tissues. *Nature, Lond. 188*:425–6. 1960. D. S. Letham.
Separation of Plant Cells with Ethylenediaminetetraacetic Acid. *Exp. Cell Res. 21*:353–60. 1960. D. S. Letham.
Semi-dwarfing Root-stocks for Apples. *Orchardist of N.Z. 33*:202, 205–06. 1960. D. W. McKenzie and H. M. Mouat.
Rootstock-scion interaction in apples, with Special Reference to Root Anatomy. *J. hort. Sci. 36*:40–7. 1961. D. W. McKenzie.
Control of Superficial Scald on Granny Smith Apples Using Pre-harvest Sprays of Diphenylamine. *N.Z. J. agric. Res. 3*:675–9. 1960. C. A. S. Padfield and R. M. Smock.
Effect of Apple and Pear Box Liners on Fruit in Cool Storage. Ibid. *3*:268–75. 1960. C. A. S. Padfield.
Harvesting is Important in Storing Apples. *Fruit and Produce,* September 1960, p. 2, 5. C. A. S. Padfield.
Secrets of Storing Apples. Ibid., July 1960, p. 5–7. C. A. S. Padfield.

GEOPHYSICS DIVISION

Director: Dr E. I. Robertson

PROJECTS

Magnetic Survey—Continuous recording and analysis of earth's magnetic field at Apia, Amberley, Scott Base, and Hallett Station; study of secular variation for preparation of magnetic charts for navigation purposes; relationship of earth current and magnetic effects; magnetic survey of New Zealand coast; earth currents at Hallett Station; magnetic characteristics at Hallett Station and Scott Base.

Geophysical Observatory—Continuous recording and analysis of ionospheric conditions at Rarotonga, Christchurch, Campbell Island, Hallett Station, and Scott Base; sporadic E investigations at all stations; diurnal perturbations at Rarotonga and Maui; ionospheric storms; low-frequency ionosonde development; f_0F_2 variations; true height analysis methods; F layer structure; recombination coefficient; and improvements to ionospheric equipment.

Continuous recording and analysis of the hard component of cosmic-radiation at Christchurch; analysis of Invercargill and Christchurch meson telescope data.

Seismological Observatory—Continuous recording and analysis of earthquake data at New Zealand, Antarctic, and Pacific island stations; elastic and flow properties of rocks; rock flow applied to New Zealand

structure; seismicity and structure of New Zealand; crustal structure of Antarctica; crustal thickness in the New Zealand region; and deep focus earthquakes.

Geophysical Survey—Crustal structure of New Zealand using explosions; gravity surveys in New Zealand and Antarctica; paleomagnetism; seismic surveys of hydroelectric dam sites; magnetic surveys and drilling for the New Zealand Steel Investigating Co.; proton magnetometer surveys in New Zealand and Antarctica; microseisms; resistivity of permafrost; and maintenance of New Zealand time service.

Volcanological investigations at the Chateau; Wairakei heat flow and heat storage; two-phase flow in boreholes; heat flux survey of North Island; fundamental study of heat sources and hydrothermal systems; model studies of hydrothermal systems; heat flow surveys of Orakei Korako and Rotokawa; and various projects directly related to the Wairakei geothermal power project.

PUBLICATIONS

Ocean Currents in McMurdo Sound. *Nature, Lond. 187*:867. 1960. A. E. Gilmore, W. J. P. Macdonald, and F. G. Van der Hoeven.

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Microseisms at Scott Base. Ibid. *3*:381–405. 1960. T. Hatherton.

Rock Magnetism in Western Europe as an Indication of Continental Growth. Ibid. *4*:320–35. 1961. F. F. Evison.

Changes in the Earth's Rotation. *Southern Stars, 18*:135–7. 1960. G. A. Eiby.

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The Variation in Latitude. Ibid. *18*:179–85. 1960. G. A. Eiby.

A Note on the Amplitude-period Relationship of Earth Noise in the 1–8 Second Range. *Bull. seis. Soc. Amer. 51*:13–16. 1961. T. Hatherton.

Electric Power Generation from Geothermal Steam at Wairakei, N.Z. *Bull. Volc. 23*. 1960. F. E. Studt and D. Doyle.

Use of Logarithmic Frequency Spacing in Ionogram Analysis. *J. Res. nat. Bur. Stand. 64*:501–04. 1960. G. A. M. King.

Relationship Between Red Auroral Arcs and Ionospheric Recombination. Ibid. *Sec D, 65 (2)*:129–35. 1961. G. A. M. King and F. E. Roach.

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Magnetic Results: Apia 1956, 1957, 1958. *N.Z. Dep. sci. industr. Res. Geophys. Div.* 1960.

Magnetic Results: Amberley 1956, 1957. Ibid. 1961.

Ionospheric Data: Godley Head 1958; Rarotonga 1958; Campbell Island 1958. Ibid. 1960.

New Zealand Seismological Report 1956. Ibid. *Seismol. Obs. Bull. E. 137*. 1960.

GRASSLANDS DIVISION

Director: Dr P. D. Sears

PROJECTS

Plant Breeding and Genetics—Maintenance and improvement of following species and strains: perennial ryegrass, Italian ryegrass, short-rotation ryegrass, cocksfoot, timothy, white clover, broad red clover (cowgrass), Montgomery red clover, *Lotus uliginosus, Lotus corniculatus,* zizag clover, long-rotation ryegrass, tall fescue, and hybrids with perennial ryegrass. Improved strains of first eight of above species already released under Government certification, but further improvement work being carried out on all above species. First nucleus seed of new long-rotation ryegrass harvested, and being used for widespread field trials by this Division and by Department of Agriculture, and seed multiplication continuing. Other projects: production of a white clover strain that breeds true for an easily identifiable leaf marking; production genetics of ryegrass; production and study of polyploids in red clover and *Lotus;* examination of certain Spanish strains of white clover for winter growth potential and ability to fix nitrogen in winter, and, by crossing with selected New Zealand strains, to incorporate these attributes into present pedigree New Zealand strains; testing of plant extracts for toxicity to various micro-organisms; improvement in techniques for certification of bred strains; transpiration rate in ryegrass varieties.

Soil Fertility—Survey of build-up of organic matter and organically bound nutrients in major North Island soil types under pasture; differential uptake of nutrients by pasture plants and mechanisms involved; sulphur nutrition of red and white clovers; major and minor element effects on establishment of clovers on Wharekohe silt loam – a Northland "gumland" soil; rate of increase of soil fertility under different pasture systems, and rate of decrease under cropping; effects of nitrogen and mineral fertilisers on pasture yield and composition.

Pasture Ecology—Seed dormancy of pasture grasses; buried seed populations of weeds and pasture species; seedling growth under different environments; pasture establishment and pasture mixtures; effects of grass grub and Argentine stem weevil on pasture productivity; effects of grazing intensity on seasonal production, and relationship with leaf area, chlorophyll content, and light interception; effects of sheep treading on pasture and soil; use of chemical weedkillers and soil fumigants; pasture management on farmlet bases on both lowland and hill country, effects of different management systems on genotyic selection within populations; effects of defoliation and treading on botanical composition, particularly in relation to *Poa trivialis* in ryegrass - white clover pastures; grazing practice in relation to position of growing point of short rotation ryegrass at its reproductive period; collaboration with Plant Chemistry Division on hogget ill thrift trials; development of pastures on Northland gumland soils; soil-pasture-animal cycle of production; collaborative trials with Crop Research Division on new potato and wheat varieties grown on high-fertility soil at Palmerston North.

Substations—At Kaikohe, Lincoln, and Gore progeny testing on single-plant and plot bases of new long-rotation ryegrass, and other species and strains under improvement; paddock-scale comparisons

under grazing of productivity of our main species and strains, and also to test reactions of new strains and of thrift of animals grazing thereon to variations in grazing intensity at different seasons; fertiliser trials for local soil conditions and for assessment of local potential in relation to climate and soil; at Te Awa hill-country area effects of stocking intensities, cattle and sheep combinations, and heavy-phosphate fertiliser, both on animal thrift and on pasture productivity, and also in relation to soil conservation on this steep, unstable hill country.

Plant Physiology—Basic study of the physiology of flowering, including examination of changes occurring at the stem apex and surrounding meristematic regions and of biochemical changes in leaves and stem apex; investigation into the factors governing flowering of white clover; measurement of way in which different types of vegetation cover modify microclimate at various times of the year, with emphasis on determining changes in air and soil temperature, light interception, air humidity within the crop, and rate of use of soil moisture; comparisons to be made between long and short ryegrass pasture, long and short white clover swards, maize and cereal crops, and bare soil; a developmental programme under way for design of controlled environment equipment.

PUBLICATIONS

The Influence of Nitrogen on Seedling and Early Growth of Perennial Ryegrass and Cocksfoot. *N.Z. J. agric. Res. 3*:399–411. T. A. O'Brien.

The Effects of Frequency and Intensity of Grazing on the Genotypic Structure of a Ryegrass Population. Ibid. *3*:442–53. R. W. Brougham, A. C. Glenday, and S. O. Fejer.

Ear Emergence in Perennial Ryegrass as Affected by Differences in Light and Temperature before Ear Initiation. Ibid. *3*:558–64. S. O. Fejer.

Internode Numbers of New Zealand Red Clovers as Influenced by Variety, Time of Closing for Seed, and Date of Flowering. Ibid. *3*:547–57. A. J. McNeur.

Productivity of Pasture Species on Hill Country. Ibid. *3*:579–91. F. E. T. Suckling.

A Leaf Squash Technique for Chromosome Studies in Grasses. *N.Z. J. Sci. 3*:293–7. G. de Lautour.

Pasture Growth and Grazing Management. *Massey agric. Coll. dairyfmg. Annu. 1960,* pp. 51–62. R. W. Brougham.

Competition between Pasture Species for Nutrients from the Soil. Ibid. pp. 75–84. R. H. Jackman.

Relationship between Levels of Iodine and Cyanogenetic Glucoside in Pasture and the Productive Performance of Sheep. *J. agric. Sci. 55*:191–6. D. S. Flux, G. W. Butler, A. L. Rae, and R. W. Brougham.

Interspecific Differences in Strontium Uptake by Pasture Plants as a Function of Root Cation-exchange Capacity. *Nature, Lond. 188*:513–4. M. C. H. Mouat.

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Evaluation of Specific and General Combining Ability in a Late-flowering Variety of Red Clover (*Trifolium pratense* L.). Ibid. *3*:680–92. L. B. Anderson.

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Grass-Clover Relationships in New Zealand. Ibid. *1960.* P. D. Sears.

The Effect of Topdressing, Oversowing, and Management Practices on the Productivity of Hill Country. *Proc. N.Z. fert. Res. Ass. Conf. 1960.* F. E. T. Suckling.

The Structure of Pasture in Relation to Production Potential. *Proc. N.Z. Soc. anim. Prod. 20*:82–92. 1960. K. J. Mitchell.

Weather and Pasture Conditions Associated with Outbreaks of Facial Eczema. *N.Z. J. Agric. 100*:177–83. 1960. K. J. Mitchell.

Growth of Pasture Species in Controlled Environment II Growth at Low Temperatures. *N.Z. J. agric. Res. 3*:647–55. K. J. Mitchell, Renate Lucanus.

The Relationship between Leaf Growth and Induction of Flowering in Long-day Plants (LDP). *Naturwissenschaften 48*:108. R. G. Thomas.

Promotion of Leaf Growth by Short Days in the Short-day Plant *Chenopodium amaranticolor. Nature, Lond. 189*:771–2. R. G. Thomas.

The Influence of Environment on Seed Production Capacity in White Clover (*Trifolium repens* L.) I Controlled Environment Studies. *Aust. J. agric. Res. 12*:227–38. R. G. Thomas.

HOP RESEARCH STATION

Superintendent: Dr R. H. Roborgh

PROJECTS

Breeding—Study of botanical characters to aid differentiation of hop varieties; introduction and evaluation of hop varieties from overseas; breeding of high-quality hop varieties tolerant to root rot (*Phytophthora* sp.), of different season, and suitable for machine picking; production and evaluation of seedless polyploids.

Ecology and Physiology—Studies of response of the hop plant to environmental factors, viz climate, soil (nutrition), planting, spacing, wiring, stringing, pruning, training, and picking.

Technology—Study of influence of variations in air flow and temperature on duration of drying and on hop quality.

PUBLICATION

Breeding of Varieties of Hops Tolerant to Root Rot. *N.Z. J. Agric. 101*:605. 1960. R. H. Roborgh.

INFORMATION BUREAU

Officer-in-Charge: Mr N. A. Marris

FUNCTIONS AND PROJECTS

The Information Bureau is responsibile for the editing and publishing of three scientific journals and other departmental publications. It also provides a central library service which includes reference facilities, cataloguing, inter-library lending, book ordering, and assistance to branch libraries, and maintains a technical information section, a publicity and public relations section, a photographic section, and a photocopy service.

A newsletter is issued each month for the information of departmental staff.

PUBLICATIONS

The *New Zealand Journal of Agricultural Research* is published in alternate months, while the *New Zealand Journal of Geology and Geophysics* and the *New Zealand Journal of Science* are published quarterly.

During the year the Bureau edited and published 24 bulletins and other publications on behalf of the Department and its branches.

The Bureau has also sponsored the preparation of branch handbooks, the first of which was published during the year.

The Technical Information Section provides most of the abstracts and articles for the *Industrial Bulletin* which is published jointly by this Department and the Department of Industries and Commerce.

Publications by officers in Head Office comprise:

D.S.I.R. Handbook, 4th ed. *N.Z. Dep. Sci. Industr. Res. Inf. Ser. No. 26.* 1960. Edited by N. A. Marris.

Crop Research Division Handbook. Ibid. No. 29. 1961. Edited by E. E. Swinbourn.

Report of the Department of Scientific and Industrial Research for the Year Ended 31 March 1960.

INSTITUTE OF NUCLEAR SCIENCES

Director: Mr T. A. Rafter

PROJECTS

Sulphur isotopes; radiocarbon dating; $^{13}C/^{12}C$ isotopic variations in nature; radioactive well-logging; ^{14}C natural variations; cosmic ray variations; tritium age measurements; radioactive fall-out; postassium-argon age measurements; theoretical studies; radiation research; fusion studies; accelerator physics.

PUBLICATIONS

A Standard Fluorescence Spectrum for Calibrating Spectro-fluoro-photometers. *J. Phys. Chem. 64*:762–4. 1960. W. H. Melhuish.

A Simple Circulating Pump for Liquids. *N.Z. J. Sci. 3*:70–1. 1960. W. H. Melhuish.

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The Origin on Terrestial Tritium. *Geochim. et cosmochim. Acta, 18*:273–7. A. T. Wilson and G. J. Fergusson.

Detection of Tritium on Paper Chromatograms. *Biochim. et biophys. Acta, 40*:522–6. 1960. A. T. Wilson.

Radiocarbon Ages of Ocean Water and Exchange Time of Carbon Dioxide from the Atmosphere to the Ocean. *Internat. oceanic Conf. New York.* 1959. G. J. Fergusson.

Physical and Chemical Investigations of Ketetahi Hot Springs. *N.Z. geol. Surv. Bull. n.s. 40*:124–44. 1960. S. H. Wilson.

The Geochemistry of Alkali Metal Ions in the Wairakei Hydrothermal System. *N.Z. J. Geol Geophys. 3*:593–617. 1960. A. J. Ellis and S. H. Wilson.

The Synthesis of Macromolecules Under Possible Primeval Earth Conditions. *Nature, Lond. 188*:1007–9. 1960. A. T. Wilson.

NEW ZEALAND GEOLOGICAL SURVEY

Director: Mr R. W. Willett

Regional PROJECTS

Paleontological—Following projects under way: Triassic-Jurassic paleontology for current geological bulletins in Hokonui, Papatowai, and Takitimu areas; tertiary macro- and micro-paleontology for Tuatapere area with special reference to the classic Clifden section; stratigraphy and faunas of New Zealand Permian; Tertiary-Cretaceous macro- and micro-faunas of Te Aute area.

Petrological—Mineralogical study of volcanic ash showers of the North Island commenced as new project; petrological and regional descriptions of rocks in connection with the 4-mile mapping project; studies of North Island ignimbrites in conjunction with geothermal petrological research.

Four-mile Project—Further sheets were completed and published: sheet 2B, Barrier; sheet 4, Hamilton; sheet 8, Taupo. In addition several sheets are in advanced stages in the cartographic section: sheet 1, North Cape; sheet 11, Dannevirke; sheet 13, Golden Bay; sheet 16, Kaikoura; sheet 18, Hurunui; sheet 22, Wakatipu; sheet 23, Oamaru. Only four sheets of the total New Zealand coverage of 27 sheets not at present being worked on.

Geochemistry—Laboratory at Chemistry Department, University of Otago, now well under way, and in addition to the high pressure/high temperature studies of mineralogical processes of various rock types, a series of coal samples have been subjected to controlled pressure and temperature experiments with a view to understanding metamorphism of coal.

Special

Glaciology—Continuation of work on Tasman Glacier with no extension contemplated.

Pleistocene History—Mapping of Pleistocene deposits in both North and South Islands directly related to the 4-mile project, detailed studies in Canterbury and terrace studies in Auckland region.

"*Geology of New Zealand*"—Material is being prepared for the "Geology of New Zealand".

Paleontology—Current projects include revision of New Zealand Trigoniiae; Permian Brachiopoda; Monograph on Otaian Mollusca from Bluecliffs; Microfaunal work on Foraminifera from Bluecliffs and Otaian and a critical examination of the Mid-Tertiary correlations based on Foraminifera. Biometric study of ranges of Foraminifera (with Applied Mathematics Laboratory). Paleobotanical work related to review of Late Cenozoic vegetation changes.

Petrology—Wairakei Geothermal project used for study of hydrochemical mineralisation.

Quaternary Tectonics and Photo-geology—Structural information gained in this project being used in several publications describing Quaternary tectonics.

Engineering Geology Projects—Geology applied to dam sites in the Rangitaiki, Motu, Tongariro, and Wanganui Rivers in North Island, and to the Benmore - Lake Tekapo area and Waitaki River in South Island.

Coal—Advice and consultations on Greymouth field where interpretation of geology is critical to solution of mining problems.

Ground Water—Advice given on ground water problems.

Industrial Minerals and Rocks—Increased attention to industrial minerals and rocks, particularly the non-metallics (limestone and dolomite); field examination of metallic minerals in Fiordland, north-west Otago, and north-west Nelson; discussions with interested parties on mineral occurrences in New Zealand.

Petroleum Geology—Assistance to petroleum search groups by paleobotanical section in examining deep well cores.

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NEW ZEALAND OCEANOGRAPHIC INSTITUTE

Director: Mr J. W. Brodie

PROJECTS

Regional

Physical Oceanography—Further work on hydrology and circulation in New Zealand off-shore waters; analysis of southern ocean circulation; field work on Hydrology of Ross Sea.

Marine Biology—Distribution, ecology, and systematics of zooplankton and phytoplankton; systematics and distribution of pelagic amphipods; distribution, ecology, and systematics of benthic faunas; field work on the New Zealand shelf survey; systematic studies of Ross Sea material; field work of an ecological survey of Foveaux Strait completed.

Marine Geology—Sampling and analysis of shelf sediments off West Coast, North Island; sedimentation in Foveaux Strait; foraminiferal sediments from New Zealand region; preparation of bathymetric charts for New Zealand area and, in more detail, for East Coast, North Island; further core sampling of deep-water sediments.

Special

Manihiki Island—General ecological survey of lagoon completed and analysis proceeding to provide data for investigations of the pearl oyster.

Wave Recording—Wave recorder operated during year at Auckland.

Nutrient Requirements of Bacteria—Further studies of nutrient needs of bacteria, involving new media derived from marine mud.

East Clive Beach—Tidal-stream investigations with particular use of aerial mapping techniques.

Tsunami—Charts constructed for prediction of arrival times of tsunami at New Zealand coast.

Fouling—Work on marine fouling concluded with publication of papers describing particular facets of survey.

Antarctic Work—Study of currents in McMurdo Sound, by observations from ice and from HMNZS *Endeavour;* benthic faunal sampling in Ross Sea area.

Cook Strait Currents—Field work completed and results published.

Facilities—A full sampling programme has been carried out during year; some cooperative work has been conducted with United States Navy Hydrographic Office on ships of Operation Deep Freeze. The Royal New Zealand Navy has again made Antarctic work possible by providing ship time for the oceanographic portion of New Zealand Antarctic Research Programme.

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PLANT CHEMISTRY DIVISION

Director: Dr A. T. Johns

PROJECTS

Protein and nucleoprotein biochemistry—Studies on mucoproteins derived from different types of bovine saliva; starch gel analysis of cattle serum and relationship of β-globulin pattern to fertility and milk yield; sequence studies on D.N.A. degraded by diphenylamine method; characterisation of R.N.A. of various origins by identification of products of ribonuclease digestion; isolation and characterisation of high molecular weight D.N.A. from plant sources; studies on ribosomes of plant tissues; studies on R.N.A. isolated from various cell fractions; Studies on *in vitro* protein synthesis using systems derived from plant tissues.

Non-protein nitrogen—Mechanism of nitrogen fixation in clover root nodules; biosynthesis of allantoin biosynthesis of cyanoglucosides in white clover; metabolism of urea in plant tissues; biosynthesis of "beaker test" substances in *Pithomyces chartarum* peptides in pasture plants.

Organic chemistry—Determination of structure of Sporidesmolides I and III from *P. chartarum;* identification of photolysis product of 2,4-dinitrophenol amino acids in aqueous bicarbonate solution; separation of peptides from mixtures with amino acids by differential photolysis; oestrogen in red clover; flavonoid compounds in pasture plants.

Carbohydrate chemistry—Carbohydrates and other constituents of grasses and clovers in relation to bloat and hogget ill thrift; carbohydrate metabolism of the rumen ciliate protozoa *Epidinium ecaudatum;* carbohydrate metabolism of rumen bacteria; development of spray reagents for use in determination of structure of oligosaccharides; isolation and identification of oligosaccharides from plants.

Microbiology—Isolation and culture of rumen bacteria and protozoa and study of their nutrition and metabolism particularly in relation to bloat; effect of innoculation of subterranean clover where rhizobia ineffective on this species are already present in the soil; use of serological identification of strains of rhizobia in field experiments; investigation of rhizobia present in agricultural lime; comparisons of nodule weights and rate of fixation in different pasture legumes.

Mineral Nutrition—Iodine nutrition of sheep; genotypic variations in plant constituents; determination of selenium in biological tissues; metabolism of selenium by plants and ruminants.

Ruminant physiology—Chemical composition of bovine salivas; salivary secretion in relation to feeding analysis of the food bolus, foaming properties and rates of fementation of rumen contents; mechanical activity of reticulum and rumen; treatment and prophylaxis of bloat; nutrition of sheep fed different strains of ryegrass; factors affecting rate of growth.

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Sporidesmolide I. a Metabolic Product of *Sporidesmium bakeri* Syd. *Biochim. biophys. Acta, 45*:411–2. D. W. Russell.

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Activity of the Partially Exteriorised Reticulum and Rumen in Conscious Sheep. *J. Physiol. 149*:14P–15P. C. S. W. Reid and D. A. Titchen.

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PLANT DISEASES DIVISION

Director: Dr E. E. Chamberlain

PROJECTS

Entomology—Life history and distribution of Chironomid midges in oxidation ponds of Auckland Metropolitan Drainage Board; biology of San Jose scale and Argentine stem weevil; studies on Orthoptera, Trichoptera, Lepidoptera, and cave insects; control of existing infestations of *Anobium punctatum;* nature and potency of a mite toxin; ionic balance following DDT poisoning.

Economic Mycology—Tomtao leaf mould, onion white rot, French bean rust, bean anthracnose, kumara tuber splitting, Verticillium wilt, strawberry black root rot, raspberry die back, dry fruit of boysenberry, die back of roses, silver leaf of stone fruits. Phytophthora root rot of apples, apple die back; association of *Phytophthora* spp. with death of pine trees; studies of field crop diseases including potato pink rot, dry rot of brassicas, leaf and stem rust of wheat, blind seed of ryegrass, and rusts of grass and clovers; selection and breeding for disease resistance; host range studies; association of nematodes with fungi as the cause of disease; surveys of diseases of field and vegetable crops and pastures.

Life history and distribution in pastures of *Pithomyces chartarum,* the fungus causing facial eczema of sheep.

Maintenance of list of all plant diseases recorded in New Zealand.

Systematic Mycology—Maintenance of herbarium; collection of fungi; studies of *Fusarium* spp. pathogenic to passion fruit vines; taxonomy and strains of *Pithomyces chartarum*; rusts of grasses; taxonomy of Streptomycetes and *Exobasidium.*

Bacteriology—Taxonomy of genus *Xanthomonas;* blast disease of pears and tomatoes; bacterial spot of plum and peach; black rot of crucifers; crown gall.

Rhizobia of legumes including maintenance of certification scheme for legume seed inoculants.

Microbiology—Breakdown of chlorophenoxy acids by plant bacteria; auxins in crown gall tissue; antibiotics in peach leaf guttation fluid; control of microbial contamination of foods and other natural products; spoilage in canned peas; heating of wool by micro-organisms; control of potato blight with streptomycin.

Plant Viruses and Virus Diseases—Virus diseases of legumes, carrots, brassicas, cereals, small fruits, pome and stone fruits, grape vines, and roses; plant resistance to viruses; heat treatment for virus elimination; cross protection.

Early stages in multiplication of tobacco mosaic virus; inhibition of virus multiplication; virus-like nucleoproteins associated with turnip yellow mosaic virus; ribonucleic acids from subcellular fractions of plant and animal cells; virus inhibitors present in aphids; role of nucleic acid in antibody production.

Plant Physiology—Blotchy ripening of tomatoes; physiological disorders of fruit trees.

Plant Therapeutants—Chemical control of diseases and pests by sprays, seed dusts, slurry treatment, seed pelleting, and by soil fumigation and addition of therapeutants to soil; testing of newly developed fungicides and insecticides; use of eradicative and protective fungicides; the development of resistance to insecticides. Particular diseases and pests under investigation are blight of potatoes and tomatoes, downy mildew and Botrytis and Fusarium rots of onions, crown gall, Verticillium wilt, black spot, bitter rot, Nectria canker, and Phytophthora rot of apples; seed-borne diseases of cereals, brassicas, peas, maize, and onions; codling moth, mealy bug, and European red mite of apples, and San Jose scale.

Servicing—Advisory service on identification and control of diseases and pests, and on industrial microbiological problems.

PUBLICATIONS

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Observations on the New Zealand Glow-worm *Arachnocampa luminosa* (Skuse). 1890. *Trans. roy. Soc. N.Z. 88*:559–74. 1960. Aola M. Richards.

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Dry Rot Resistance in Swedes. *Commonw. Phytopath. News 6*:59. 1960. H. C. Smith.

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Hydrangea Ringspot Virus in New Zealand. *N.Z. J. Sci. 3*:559–62. 1960. A. D. Thomson.

New, easy-to-construct simpler Trickle Irrigation System. *N.Z. Commerc. Grower 15 (11)*:8–9. 1960. A. H. Uljee.

Effect of Tobacco Mosaic Virus and Potato Virus Y on Infection by Potato Virus X. *Virology, 13*:262. 1961. A. D. Thomson.

Possible Occurrence of Interference Systems in Virus-infected Plants. *Nature 187*:761–2. 1960. A. D. Thomson.

Variation in Plant Viruses. *Adv. Vir. Res. 7*:163–91. 1960. A. D. Thomson.

Insects on Citrus. *N.Z. Ent. 2 (4)*:22–4. 1959. K. A. J. Wise.

SCIENTIFIC LIAISON SERVICE

Officer in Charge: Mr N. A. Marris

London ACTIVITIES AND PROJECTS

During the year the Senior Scientific Liaison Officer retired from the Council of the Royal Institute of Chemistry as Overseas Representative, having completed his three-year term of appointment. He has been appointed to the Science Committee of the British Council under the chairmanship of Sir Patrick Linstead, Rector of Imperial College.

Other official bodies on which the office is represented include: Commonwealth Advisory Committee on Defence Science, Commonwealth Agricultural Bureaux Executive Council, International Standards Organisation Technical Committees, Pest Infestation Board, and the Board of Governors of Imperial College of Science and Technology.

Among meetings and conferences attended by representatives of the Liaison Office were: Royal Society Meeting on Space Probes; European Meeting of Satellite Launchers; International Geological Congress, Copenhagen; International Mineral Processing Congress; the British Commonwealth Scientific Committee, in connection with which an extensive tour was made to see various facets of British scientific endeavour; and the five-yearly meeting of the Commonwealth Agricultural Bureaux, during which visits were made to the 10 bureaux and two institutes for which the C.A.B. is responsible in the United Kingdom.

The Senior Scientific Liaison Officer was elected Vice-chairman of the C.A.B. and also continues to serve as Council representative on the Management Committee of the Bureau of Animal Nutrition.

The services of the office have been made available for various scientific visitors from New Zealand, included among whom were 19 officers of the Department and three others who are closely associated with the Department. Besides short-term visitors from New Zealand the office has assisted and acted on behalf of a number of New Zealand scientists in this country on scholarships or fellowships or on study leave.

Washington

The office assisted several New Zealand scientists with their travelling and appointment schedules this year. A large number of publications and reports, some dealing with growing public interest in scientific achievement and advancement in fields such as radiation, space and missiles, patents and trademarks, atmospheric information, water resources, copyright law revision, and documentation, indexing, and retrieval of scientific information, has been procured and forwarded. Information and descriptive literature on equipment and materials of value and interest to scientists has been obtained.

SOIL BUREAU

Director Mr N. H. Taylor

PROJECTS

Soil Survey—Soils of New Zealand (16 m./in.); South Island (4 m./in.); Rangitaiki Plains (40 ch./in.); Raglan County (2 m./in.); Wairoa Flats (80 ch./in.); Kairanga County (40 ch./in.); Paparua County (40 ch./in.); Upper Clutha Valley (40 ch./in.); Maniototo Plains (40 ch./in.). Survey of chemical and physical properties of soil–expressed as single factor maps.

Soil Chemistry—Potassium-supplying power of soils; forms of phosphorus in soils; comparison of potassium fertilisers; survey of available minerals in soils as extracted by sweet vernal; improvement in analytical methods–sulphur; analysis of representative profiles; nutrient cycle in hard-beech forest; sulphur in soils.

Soil Physical Chemistry—Systematic survey of inorganic soil colloids; mechanism of ion adsorption; forms of iron and aluminium in soils; forms of phosphate in topdressed soils; source of radioactivity in soils; surface acidity of allophane.

Soil Physics—Survey of physical properties of main soil groups; pumice and perlite as soil amendments; soil density and storage of heat; establishment of texture standards for New Zealand soils.

Soil Biology—Biology and biochemistry of soils under forest and under pasture following forest; microbiology of Antarctic and Pacific Island soils; bacteria, yeasts, algae, and soil animals in New Zealand soils; effect of pH on availability of plant nutrients in New Zealand soils using ryegrass (*Lolium perenne*); biochemical activities of soils; acidity complex in yellow-brown earths in relation to plant growth.

Soil Engineering—Rapid and self-recording consolidation tests; significance of triaxial tests on dry clay; development of sensitivity by a soil as a result of reducing processes; strength of a soil at the liquid limit; engineering properties of some New Zealand topsoils and subsoils;

corrosion of mild steel, concrete, and cement asbestos in soils; standardisation of New Zealand liquid-limit machines; changes in thixotropic properties of clays resulting from changes in pH.

Projects with Other Organisations—Correlation of land-use data with South Island and other soil surveys; detailed physical, chemical, biological, and pedological study of 54 representative soil sites; water and mineral balances in Taita native catchment – hydrology and chlorine balance; mineralogical examination of sand fractions of some New Zealand soils; effect of stock treading on pasture soils; effect of grazing animals on potash status of soils – yellow-grey earth; physiology of *Pithomyces chartarum* – factors affecting toxicity of fungus; soil and leaf micro-organisms in relation to ryegrass staggers in sheep; relation between dental caries and soil type.

PUBLICATIONS

Volume changes during undrained triaxial tests of saturated dilatent granular materials. *Geotechnique 9*:174–82. 1959. P. L. Newland and B. H. Allely.

A study of the consolidation characteristics of a clay. *10*:62–74. 1960. P. L. Newland and B. H. Allely.

Morphogenesis in the ciliate *Bresslau vorax* Kahl and phlogeny of the Colodidae. *J. Protozool. 7* (1):26–35. 1960. J. D. Stout.

Micro-determination of cation exchange capacity and total exchangeable bases. *Soil Sci. 89*:202–8. 1960. L. C. Blakemore and A. J. Metson.

Biological studies of some tussock grassland soils. *N.Z. J. agric. Res. 3*:197–244 —1960.

XII. Soils and vegetation of two cultivated sites. pp. 197–202. R. H. Thornton.

XIII. Fungi of two cultivated soils. pp. 203–6. R. H. Thornton.

XIV. Yeasts of two cultivated soils. pp. 207–13. Margaret di Menna.

XV. Bacteria of two cultivated soils. pp. 214–23. J. D. Stout.

XVI. Non-symbiotic nitrogen fixing bacteria of two cultivated soils. pp. 224–9. D. J. Ross.

XVII. Nitrifying activities of two cultivated soils. pp. 230–6. D. J. Ross.

XVIII. Protozoa of two cultivated soils, pp. 237–44. J. D. Stout.

Soil studies using sweet vernal to assess element availability. IV. Phosphorus. Ibid. *3*:279–99. 1960. N. Wells and W. G. M. Saunders.

A note on the occurrence of non-symbiotic nitrogen fixing bacteria in some introduced pasture soils. Ibid *3*:245–9. 1960. D. J. Ross.

Some observations on the occurrence of *Sporidesmium bakeri* Syd. and facial eczema disease in the field. Ibid. *3*:300–13. R. H. Thornton and D. P. Sinclair.

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Clay minerals, accelerated erosion of sedimentation of the Waipoua River Catchment. *N.Z. J. Geol. Geophys. 3*:184–91, 1960. G. G. Claridge.

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Soils of the inner islands of the Hauraki Gulf. *Proc. N.Z. ecol. Soc. 7*:27–9. 1960. N. H. Taylor.

Bacteria of soil and pasture leaves at Claudelands Showgrounds. *N.Z. J. agric. Res. 3*:413–30. 1960. J. D. Stout.

The peat soils of the Auckland Islands. Ibid. *3*:526–46. 1960. M. L. Leamy and L. C. Blakemore.

Plant growth in expanded perlite. Ibid. *3*:592–7. 1960. T. M. Morrison, D. C. McDonald and Jean A. Sutton.

Yeasts from soils under forests and under pastures. Ibid. *3*:723–32, 1960. Margaret di Menna.

Changes in the pore space of a pasture top soil under animal treading. Ibid. *3*:663–74, 1960. M. G. Gradwell.

Fungi of some forest and pasture soils. Ibid. *3*:699–711. 1960. R. H. Thornton.

An association between dental caries and certain soil conditions in New Zealand. *Nature, Lond. 186*:695–6. 1960. T. C. Ludwig, W. B. Healy and F. L. Losee.

Microbiology of some soils from Antarctica. Ibid. *188*:767. 1960. Elizabeth A. Flint and J. D. Stout.

Physiological studies of some common fungi from Grassland soils. *N.Z. J. Sci.* *3*:219–57. 1960. D. J. Ross.
Some factors affecting the sporulation of *Sporidesmium bakeri* Syd. in culture. Ibid. *3*:441–52. 1960. D. J. Ross.
The size, shape and density of spores of *Pithomyces chartarum* (Berk and Curt). M. B. Ellis. Ibid. 412–4. 1960. R. Q. Packard.
Polarisation measurements of steam bore casings at Wairakei, New Zealand. Ibid. *3*:523–33. 1960. G. G. Claridge and H. R. Penhale.
Yeasts from Antarctica. *J. Gen. Microbiol.* *3*:295–300, 1960. Margaret di Menna.
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Land in British Honduras. *Colon. Off. Lond. Colon. Res. Publ. No. 24.* 1959. A. C. S. Wright, D. H. Romney, R. H. Arbuckle, and V. E. Vial.
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Problems of development in the Wanaka district. *N.Z. Inst. agric. Sci. Proc. 1960.* pp. 60–63. M. L. Leamy and R. C. Schofield.
Soil frost action in snow tussock grassland. *N.Z. J. Sci.* *3*:580–90. 1960. M. G. Gradwell.
Mechanisms of ion adsorption by inorganic soil colloids. Ibid. *3*:563–79. 1960. M. Fieldes and R. K. Schofield.
Some factors affecting the Potassium status of New Zealand soils. *Potash Rev. Subject 4*, 24th suite, August 1960. A. J. Metson.
Work at Soil Bureau. *Sheepfmg. Annu.* 1960. 65–73. N. H. Taylor.
Scientists make soil survey of Ross Dependency. *Antarctica* 2 (5):171–2. 1960. J. D. McCraw.
Soils of Wellington. In "Science in Wellington". *Royal Soc. N.Z.* pp. 11–13. 1960. H. S. Gibbs.
Growth of fungi in some forest and grassland soils, in "Ecology of Soil Fungi" pp. 84–91. Liverpool University Press. 1960. R. H. Thornton.

TOBACCO RESEARCH STATION

Director: Mr R. Thomson

PROJECTS

Seedling Bed Work

Alternatives to steam sterilisation for control of weeds and disease; control of bed rots (*sclerotinia* and *botrytis*) by use of fungicides; alternative methods of raising seedlings.

The Crop in the Field

Cultural—Cultivation practices in relation to yield of leaf and spread of mosaic; irrigation studies and water requirements of tobacco; control of weeds by the use of chemical weedkillers and effect of such chemicals on the tobacco crop; effect of various cultural practices on yield and quality of different varieties.

Cover Crops—Fertiliser requirements of cover crops; testing various cover crops; trial of growing tobacco with alternate grass strips.

Variety Trials—Testing of new overseas and locally produced varieties, both burley and flue-cured.

Plant Breeding—Breeding for resistance to black root-rot, mosaic and verticillium wilt; studies of inheritance.

Seed Production—Testing of locally raised lines against original importations; production of nucleus lines of progeny tested seed; maintenance of supply of seed for the industry.

Kilns and Curing—Study of condition known as "chilling"; investigation into methods of handling and curing untied leaf; technical advice on kiln design and management.

Diseases—Control of verticillium wilt by soil treatment; use of fungicides to control sclerotinia and botrytis in the field; effect of skim milk on the spread of mosaic during handling and cultivating; study of kiln conditions conductive to mould development.

WHEAT RESEARCH INSTITUTE

Director: Mr E. W. Hullett

Services—Experimental determination of milling and baking qualities of new wheats produced at Crop Research Division; routine wheat and flour testing for millers, bakers, and Wheat Committee; technical advisory service for millers, bakers, and other flour users.

Projects—Development of rapid quality tests to facilitate best utilisation of New Zealand wheat crops; study of theoretical and practical significance of new continuous breadmaking processes and their impact on wheat-breeding objectives; wheat proteins in relation to dough structure and action of maturing agents; dough ripening process and causes of grey crumb colour in bread; production control in mechanised bakeries; improvements in efficiency of bakers' ovens; guarding bakery machinery; evaluation and calibration of rapid grain moisture meters.

PUBLICATIONS

Examination of Wheat Gluten by Partial Solubility Methods. I – Partition by Organic Solvent. *J. Sci. Fd. Agric. 11*:320–37. 1960. P. Meredith, H. G. Sammons, and A. C. Frazer.

Note on Breadmaking without Bulk Fermentation: the Effect of Mixing and Stage of Addition of Potassium Iodate. *N.Z. J. Sci. 3*:290–2. 1960. T. A. Mitchell and C. A. Crawford.

The Effects of New Needs and Machines on Flour and Bread Processes. *Proc. 9th N.Z. Sci. Congrs.* 1960. E. W. Hullett.

New Work on the Modern Continuous Process (of Breadmaking). *Australasian Baker. 64*:20. Jan. 1961. T. A. Mitchell.

Fermented Buns. *N.Z. Baker and Confectioner.* pp. 9–11. Oct. 1960. J. Nolan.

INCORPORATED RESEARCH ASSOCIATIONS

NEW ZEALAND LEATHER AND SHOE RESEARCH ASSOCIATION (INC.)

Director: Mr F. W. Woodroffe

PROJECTS

Use of Naphthalene and Boric Acid in Hide Curing—The use of naphthalene and boric acid as additives to hide-curing salt has been further developed and the importance of boric acid to prevent the growth of purple organisms has been confirmed. Work on the usage of the salt has established the comparative purity of the used salt so that instead of disposing of it after three usages, it can be used to prepare a solution of at least as high a purity as is obtainable from new salt.

Zirconium Salts as Fillers—The filling of chrome-tanned leathers, both calf and sides, with zirconium salts has been developed. These basic salts have very large molecular weights and the leather produced by this method shows a structure under the electron microscope similar to vegetable-tanned leather. Chrome-tanned leather is lacking in filling power. Retannage with vegetable tans modifies the properties of the chrome leather and, as there is an affinity between the chrome compound and the vegetable tanning, the filling is not very effective in the open flanks. Synthetic resins are better than vegetable tans as with them there is a definite preferential absorption in the looser parts. However, all firms have not been successful with resin treatment and therefore this development with zirconium salts is most welcome. The application is simple and the penetration of the hide structure is surprisingly good. The filling is superior to that of either of the older processes. Physical tests have shown that the properties of the leather are quite satisfactory.

Military Footwear—The production of a new Army boot has been successfully achieved. The re-designed boots have a special upper leather of remarkable softness and flexibility, and have met all the requirements of the Army Quartermaster's Department.

Other Projects—Curing of hides and calfskins; use of low alkali paints in fellmongering; temperature effects in the liming process; deliming as a substitute for bating; zirconium retannage of chrome sides to give a white leather; testing service for locally made synthetic soles, fibre boards, leather boards, and adhesives.

PUBLICATIONS

Fellmongers Handbook. *N.Z. Dep. Sci. industr. Res. Inf. Ser. 25.* 1960. M. S. Carrie and F.W. Woodroffe.

RESEARCH INSTITUTE OF LAUNDERERS, DRYCLEANERS, AND DYERS OF NEW ZEALAND (INC.)

Director: Mr N. S. Whittall

During the year a number of technical conferences were held including papers given by Mr U. N. Audigier of the British Launderers Research Association, and special demonstrations on textile finishing techniques were arranged in the main centres.

PROJECTS

Laundry Bleaching Agents—Following investigations into the degradation brought about by Sodium Hypochlorite bleaching agents on cellulose fabrics, particularly those treated to produce the so-called no-iron drip-dry finishes, Sodium Perborate has been recommended as the standard laundry bleaching agent and widely adopted by the trade.

Anti-shrink Processes for Wool—Because the shrink resistant finishes being employed in a number of New Zealand mills bring about a slight chemical degradation of the wool, the tendency of this wool to pick up metallic ions from the solution is increased, particularly when iron is present. As a result, shrink-resistant garments tend to discolour readily when washed in such water especially when subjected to boiling.

Considerable work has been carried out to produce suitable washing formulae which will eliminate the metallic staining of shrink-resistant treated garments and, as an alternative, methods have been investigated to restore those garments which have been stained in this way.

Similar work has been carried out for drycleaning in which this type of staining is also a problem.

Other Projects—Investigation of causes of damage and staining of garments during wear, drycleaning, and laundering; selection of fabrics for new uniforms (in collaboration with Government Stores Board and Army Department); maintaining of textile testing service for manufacturers, importers, and Government Departments.

THE DAIRY RESEARCH INSTITUTE (N.Z.)

Director: Dr H. R. Whitehead

The financial year of the Institute ends on 31 July next, after which a separate report will be issued. The investigations under way include studies of the following subjects:

PROJECTS

Cheesemaking—Chemical and biochemical studies on substances responsible for flavour of Cheddar cheese, their nature and mode of formation; manufacture of Cheddar cheese under controlled bacteriological conditions with particular reference to effect of various bacteria on flavour development; phage relationships amongst single strains of *Str. Cremoris* and *lactis* used as starters in cheesemaking and properties of the phages; incidence and origin of staphylococci in Cheddar cheese; factors influencing incidence of tallowy discolouration in cheese; investigation of cheesemaking process with view to ultimate mechanisation and

experiments in mechanisation on pilot-plant scale; some aspects of production, wrapping and packing of rindless cheese and properties of wrapping materials used.

Buttermaking—Production of high-flavoured starter butter of good keeping quality; pH in relation to keeping quality of butter; inter-relationship of effects of salt, acidity, and copper contents of butter on development of fishy flavour; salt particle size in relation to incidence of spotted colour in butter.

Casein and Other Dried Products—Development of process for continuous coagulation in lactic casein manufacture; equipment for dewatering casein; recovery of casein fines from whey; conditions affecting high-capacity sifting rates for dried casein; factors controlling solubility and viscosity of casein solutions; production and usage of whey powders; production of sodium-caseinate; production of cheese powder; equipment for increased-capacity operation of existing spray drying plant.

Dairy Husbandry—Effect of stage of maturity of grasses consumed by cows and of irrigation of pasture on properties and vitamin A content of butterfat.

Factory Steam Supplies—Development of coal handling and measurement equipment for small boilers; trials of packaged boilers; trials of boiler "wetback" feedwater heater.

Engineering Advisory and Service Section—Detailed advisory work on boiler installations, steam supplies, and other factory equipment; testing of dairy machinery.

PUBLICATIONS

Some Volatile Compounds in New Zealand Cheddar Cheese and their possible Significance in Flavour Formation. I. Identification of the Volatile Carbonyl Fraction. *J. Dairy Res.* *26*:265. 1959. J. R. L. Walker and R. J. Harvey. II. Volatile Compounds of Sulphur. Ibid. *26*:237. 1959. J. R. L. Walker.

The Use of an Oxidation-Reduction Indicator to Compare the Oxygen Permeabilities of Films for Rindless Cheese. Ibid. *26*:281. 1959. R. M. Dolby.

Production of Acetone and Acetaldehyde by Lactic Streptococci. Ibid. *27*: 41. 1960. R. J. Harvey.

Chemical Changes in Dried Skim-Milk During Storage. Ibid. *27*:59. 1960. E. L. Richards and M. R. Chandrasekhara.

Studies on the Manufacture of Sweet Cream Starter Butter. I. Effect of Cream-Holding Temperature. Ibid. *27*:81. 1960. F. H. McDowall, J. A. Singleton, and B. S. Le Heron.

Studies on the Manufacture of Sweet Cream Starter Butter. II. Effect of Variation in Proportion of Starter added to Cream. Ibid.*27*: 91. 1960. F. H. McDowall, J. A. Singleton, and B. S. Le Heron.

Studies on the Manufacture of Sweet Cream Starter Butter. III. Effect of Age of Starter Cultures at Time of Inoculation. Ibid. *27*:165. 1960. F. H. McDowall, J. A. Singleton, and B. S. Le Heron.

Methods for Investigating the Bacteria in Young Cheddar Cheese: Inhibition of Starter Streptococci with Bacteriophage and a Bromopropionic Acid. Ibid. *27*: 1. 1960. P. S. Robertson.

Phage Resistance in Pure Strains of Cheese Starter Streptococci. Ibid. *27*:161. 1960. P. S. Robertson.

Reviews of the Progress of Dairy Science. Section D. Nutritive Value of Milk and Milk Products. Ibid. *27*:309. 1960. W. A. McGillivray and J. W. G. Porter.

Chlorination of Butter Wash Water in Relation to Quality of Sweet Cream Starter Butter. *Aust. J. Dairy Tech.* *14*: 137. 1959. F. H. McDowall, J. A. Singleton, and B. S. Le Heron.

Quality and Keeping Quality of Non-Washed Unsalted Butter. Ibid. *14*:125. 1959. F. H. McDowall, J. A. Singleton, and B. S. Le Heron.

Methods of Controlling The Consistency of Butter. Ibid. *14*:103. 1959. R. M. Dolby.

Chemical Engineering and Dairy Processing. Ibid. *15*: 81. 1960. J. K. Scott.

THE MEAT INDUSTRY RESEARCH INSTITUTE OF NEW ZEALAND (INC.)

Director: Mr N. H. Law

The new laboratories of the Institute at Hamilton were officially opened by His Excellency the Governor-General on 4 March 1961. The opening of the new laboratories is an important milestone in the continued progress of our great meat industry and a fitting tribute to an industry which is striving constantly to maintain its high reputation in the meat markets of the world.

PROJECTS

Muscular Contraction—Identification by paper chromatographic methods of muscle relaxing factor as α-glycerophosphate plus orthophosphate plus magnesium ions; inhibiting effect of relaxing factor on adenosine triphosphatase (ATP-ase) activity of muscle fibre particles.

Structural and Enzymic Aspects of Muscle—Comparison of subunits of the structural muscle protein, myosin, obtained by urea, mild alkali, or mild heat coagulation methods; study of significance of the enzyme adenylic acid deaminase, and comparison of its concentration in different muscles of one animal and between species; investigation of possible development of a histo-chemical staining method for cellular localisation of this enzyme; extension of work on contraction pattern sequences in rigor beef muscle to other animals, including fish and crustaceans.

Nucleotide Metabolism in Muscle—Mechanism whereby adenosine triphosphate is synthesised from inosine monophosphate; relation of this mechanism to chemical events associated with muscular contraction and rigor changes in meat.

Microbiology—Completion of three-year survey of salmonella infection in apparently healthy animals at time of slaughter; factors concerned in microbial spoilage of meat and meat products; survey of bacterial populations of freshly prepared meats of various types to provide basis for tentative bacteriological standards for meat quality; study of water supply and waste disposal problems facing meat industry.

Steam Survey—Steam supply and demand patterns for a freezing works; relationship between stock killed and steam consumed at different works.

Cooling and Weight Losses of Carcases—Continuation of work on cooling rates and weight losses of carcases held on cooling floors.

Refrigeration—Rates of freezing of lamb carcases, especially in blast freezers.

PUBLICATIONS

Proteolysis in the Storage of Beef. *J. Sci. Fd. Agric. 11*:520–5. 1960. R. H. Locker.
Bone-taint in Beef. II. Bacteria in Ischiatic Lymph Nodes. Ibid. *11*:436–41. 1960. P. M. Nottingham.
Identification of the Muscle Relaxing Factor. *Biochem. Biophys. Res. Comm. 3*:233–8. 1960. B. B. Marsh.
The Effects of Carnosine and Anserine on the Glycolytic Reactions in Skeletal Muscle. *Arch. Biochem. Biophys. 89*:296–302. 1960. C. L. Davey.
The Significance of Carnosine and Anserine in Striated Skeletal Muscle. Ibid. *89*:303–08. 1960. C. L. Davey.
Symposium on Engineering in the Meat Industry: Steam Usage. *N.Z. Engng. 15*:413–7. 1960. R. L. Earle.

THE NEW ZEALAND FERTILSER MANUFACTURERS' RESEARCH ASSOCIATION (INC.)

Director: Dr B. W. Doak

PROJECTS

Movement and Breakdown of DDT in Soils—The rapidity of control of grass grub in pastures by DDT depends primarily on the amount of rainfall immediately after DDT application. Under very dry conditions, particle size of the DDT plays an important part. The solubility of DDT in rainwater is very low, but is sufficiently high to allow penetration of DDT into the soil. Very finely divided DDT will dissolve more quickly than does coarser material.

Under the rainfall conditions of the greater part of the North Island, very satisfactory control of grass grub has been obtained using so-called wet-mix DDT super, and, except where application has been made in the dry part of the year, control with wet mix has been almost as rapid as with dry-mix material using micronised DDT. On Papatoetoe silt loam a trial using different rates of DDT super application, both dry and wet mix, has shown no difference between the two products in rate of penetration. The rate of breakdown of the DDT appears to be substantial over the first few weeks and then settles down to a fairly constant lower rate. There is evidence of downward migration in the soil up to a period of at least three months after application. Trace quantities of DDT have now been detected at up to 5–6 in. depths, especially with the heavier application rates.

There has been no significant difference between the behaviour of wet- and dry-mix DDT super in either recovery or rate of downward movement.

As there is evidence that the rate of DDT breakdown varies with different soils, trials are being laid down on other soil types, especially very freely draining soils such as pumice soils and sand.

Other Projects—Acidulation studies on phosphate rocks; effect of various phosphatic fertilisers on pasture yield and effect on soil constituents; soil sulphur investigations; analytical methods for fertiliser analysis.

PUBLICATIONS

Control of Cattle Ticks with DDT Superphosphate. *N.Z. J. Agric. 101*:331–4. 1960. F. B. Muller.

THE NEW ZEALAND POTTERY AND CERAMICS RESEARCH ASSOCIATION (INC.)

Director: Dr L. Swindale

PROJECTS

Autofeed stoker—Although it has been long recognised that the combustion efficiency of coal-fired kilns and boilers is higher when they are stoked automatically rather than hand fired, the usual type of automatic underfeed stoker cannot be used with low-grade New Zealand coals because the nature of the resulting fuel bed produces unsatisfactory firing conditions. A gravity feed automatic stoker was designed at PACRA to take full advantage of the free-flowing nature of these low-grade non-coking coals and was successfully used in pilot-scale laboratory trials and

full-scale trials on boilers. It was then tried out on an industrial ceramic kiln in the firing of salt-glazed sewer pipes. The early trials showed what modifications in design were required, and when these were incorporated the stokers gave excellent results. Temperature distributions throughout the kiln during all periods of firing were very much better than in hand-fired kilns; kiln maintenance costs were no greater, no coal ash was deposited on the sewer pipes and their quality was excellent. The project has thus achieved its objectives of smoke elimination, increased cleanliness and saving in fuel costs—all improvements on the conventional method of hand firing. The development of this autofeed stoker now offers the industry a practical alternative to hand firing, where previously it had seemed the only answer would be the use of liquid fuel.

Brick-mortar bond—Although it is known that the weakest part of any masonry structure is the bond between the mortar and masonry units, very little is known of the factors which control the strength of this bond. In New Zealand, where the risk of earthquakes limits the use of masonry in load-bearing structures, the strength of the bond is of the utmost importance and a long-term project has therefore been undertaken to investigate the brick-mortar bond and to determine its optimum strength. From this it is hoped to formulate principles and methods of brick-laying which will allow the strongest practical bonds to be achieved consistently throughout the country, taking into account local variations in materials.

First experiments on the properties of mortars indicate that two of their most important properties are initial flow and water retentivity. Initial flow is a measure of the plastic consistency of a mortar and water retentivity is its ability to retain water against suction so that a mortar mix stays wet long enough to develop set and strength. To achieve good bond strength these two properties must be balanced in relation to the characteristics of the brick used.

As a result of the careful control of conditions and materials a high standard of reproducibility of results has been achieved. It is now possible to mix mortars to desired characteristics of initial flow and retentivity. Experiments have shown that the initial flow of mortar increases with increasing water content and with decreasing amounts of lime, but the retentivity of the mortar increases with increasing lime content. A further discovery which may prove significant is that the initial moisture content of the cement and of the lime has a marked effect on the initial flow of the mortar mix.

Other Projects—Genetic survey of New Zealand ceramic resources; study of ceramic properties of New Zealand halloysite and vermiculite; properties of New Zealand aluminium and magnesium compounds as refractory materials; theory of drying; heat transfer in kiln foundations; standardisation of thermal expansion measurements; development of standard quality control methods; brick-mortar bond; fire resistance of hollow clay blocks; weathering reactions; structural applications of New Zealand's fired clay products.

PUBLICATIONS

Particle Size Reduction of Clay Minerals by Freezing and Thawing. *N.Z. J. Geol. Geophys. 3*:337–43. 1960. I. C. McDowall.

A Mineralogical Study of Soil Formation in Four Rhyolite-derived Soils from New Zealand. Ibid. *3*:141–83. 1960. L. D. Swindale and M. L. Jackson.

A Review of the Influence of Preparation and Testing on the Modulus of Rupture of Unfired Clay. *Bull. Amer. ceram. Soc. 39*:443–7. I. C. McDowall.

The Utilization of Structural Clay Products. *N.Z. Engng. 15 (2)*: 64–6. 1960. V. A. Youl.
Moisture Movement and Readsorption Phenomena in Dried Clay Articles. *J. Amer. ceram. Soc. 43*:553–610. I. C. Hope, J. Gabriel and I. C. McDowall.
Clay Field Tiles, Domestic and Special Applications. *Building Progress, 25 (8)*:20–25. 1960. R. G. Hobday.

THE NEW ZEALAND WOOL INDUSTRIES RESEARCH INSTITUTE (INC.)

Director: Dr L. F. Story

PROJECTS

Effect of Staple Strength on Carding and Combing—Full scale manufacturing trials have been carried out using series of medium crossbred (48s.) and fine halfbred (58s.) wools differing in staple strength. These have shown that staple strength has a marked effect on worsted processing performance, sound wools giving a higher tear and a longer and squarer top than tender wools. The level at which a break occurs in tender wools is of considerable significance.

Effect of Hard Water in Woolscouring—Hardness in the water has been found to be of little account in comparison with the quantity of calcium compounds carried into the scouring liquors on the wool (as a component of suint). However the wool absorbs calcium subsequently in the rinse bowls, so that if a running rinse of hard water is used there is opportunity for the wool to absorb considerable quantities of calcium.

Other Projects—Devising of practical method for measuring degree of fibre alignment in successive stages of topmaking; effluent disposal; comparison of detergents and builders in scouring; effect of scouring method on subsequent processing; strength of wool in relation to growth and manufacturing; fibre breakage in processing; effect of fibre length in spinning; examination of finishing methods; equipping of 14 works with rapid moisture testing apparatus designed by Dominion Laboratory.

PUBLICATIONS

Staple Strength. I. The Measurement of Staple Strength. *N.Z. J. agric. Res. 3*:503–25. 1960. D. A. Ross.
The Strength of Fibre Bundles and Tops. *J. text. Inst. 51*: T240–59. 1960. D. A. Ross.
Investigations in Woollen Ring Spinning. Ibid. *51*: T1089–1108. 1960. R. L. Bratt.
The Effect of Staple Strength on Carding and Combing. Ibid. *51*:T907–21. 1960. D. A. Ross, R. L. Bratt and L. F. Story.
Byproduct Recovery and Effluent Treatment in Woolscouring. *Wool 3 (3)*:55–7. 1960. R. G. Stewart.

GRANT-AIDED RESEARCH IN OTHER INSTITUTIONS

On page 9 are shown the annual grants made by the Department to assist research in other institutions.

CANTERBURY AGRICULTURAL COLLEGE

Principal: Dr M. M. Burns

PROJECTS

Agricultural Economics Department—Interfarm differences in productivity and efficiency; price and market research.

Agricultural Engineering Department—Tractor guiding instrument; hay curing.

Agricultural Microbiology Department—Persistence of pseudomonas aeruginosa in wool; microbiology of the fleece; studies on *Peyronellaea glomerata* – fungus tip of wool; thermophilic bacteria; brown stain in pelt wool; soil microbiology.

Agricultural Zoology Department—Population dynamics of birds; control of insect pests.

Animal Science Department—Border-Romney Trial (Grades); interbreeding in Border-Romney stud; intake; efficiency of wool growth; oestrogens in lucerne; creep feeding.

Plant Science Department—Pasture mixtures at Ashley Dene; improvement of *Medicago glutinosa*; lucerne agronomy studies; physiological studies in lucerne.

Soil Science Department—Quantitative pedology; factors affecting growth of legumes; selenium studies; lime research; clay mineral studies.

PUBLICATIONS

Damage to Wheat Seed and Pea Seed in Threshing. *J. agric. engng. Res.* 387. 1960. D. L. King and A. W. Riddolls.

A Preliminary Account of a Regular Fluctuation in California Quail in Central Otago. *Proc. N.Z. econ. Soc.* 7:9–11. 1960. G. R. Williams.

Soil Fertility and Herbage Productivity. *J. Brit. grassl. Soc. 15*:74. 1960. T. W. Walker.

Bacterial Discolouration of Wool. International Wool Textile Conference. 1960. *J. text. Inst. 51 (12, Pt. 1)*:1857 1960. I. E. B. Fraser and E. V. Truter.

Constitution of Suint. III. Colouring Matter. Int'l Wool Text. Confer. 1960. Ibid. *51 (12, Pt. 1)*:863 1960. I. E. B. Fraser and E. V. Truter.

Methods of Analysis and the Influence of Fleece Characters on Unit Area Wool Production of Romney Lambs. *Aust. J. agric. Res. II*:851. 1960. A. E. Henderson and B. I. Hayman.

Rhizobium Innoculation of Lucerne. *N.Z. J. agric. Res. 3*:804–19. 1961. I. D. Blair and A. Bennett.

Cereal Root Rots in New Zealand. *Proc. Aust. Conf.* on *Root Rots in Wheat.* C.S.I.R.O. *2*:51–8. 1961. I. D. Blair.

CAWTHRON INSTITUTE

Director: Dr C. R. Barnicoat

PROJECTS

Hops—Studies of amino acid requirements of the infective organism (*Phytophthora cactorum* (Schroet)) of blackroot-rot; manurial trials; propagation of new varieties bred at Hop Research Station, Riwaka.

Tobacco—

Studies on chemical composition in relation to quality: Correlation of nicotine: nornicotine ratio with leaf quality as classified by simple burn tests; analysis of ground-dried kiln tobacco for nicotine and nornicotine; influence of variety, treatment, soil, and climate on alkaloid content (with Tobacco Research Station).

Proteins and derivatives: Systematic examination of nitrogenous fractions of tobacco leaf, involving adaptation of existing methods of analysis.

Tomatoes—Mineral metabolism studies requiring extensive analyses of leaves and fruit, including the ultrafilterable fractions, from plants grown in nutrient solutions; biochemical studies of mechanisms causing browning of tissue around vascular strands underlying "cloudy" patches; growth trials in unheated glasshouses, including comparison of soils of high and low base saturations, with similar fertiliser treatments.

Raspberries—Varietal trials; manurial and under field conditions, the former designed to study possible nutritional factors concerned in "leaf burn".

Apples—Bitter-pit investigations: Field trials involving manurial and foliar applications of macro and over 30 potential micro elements; comparative chemical and histological studies of normal and pitted apple tissues.

Soils—Investigations into best methods and rates of applying fertilisers, particularly lime, to acid soils derived from granite, Moutere gravels, and "semi-pakihi" country; mapping and chemical analysis required for completing soil survey of Waimea County; soil and other chemical analyses for the Hop and Tobacco Research Stations.

PUBLICATIONS

Chemical Aspects of Dental Research. *J.N.Z. Inst. Chem. 21*:3–16. 1960. C. R. Barnicoat.

Boron Investigations at the Cawthron Institute. *Dep. Sci. industr. Res. N.Z. soil-News*. No. 5. 1960. E. Chittenden.

Radioactivity in the Service of Man. *Cawthron mem. Lect. No. 34*. 1959. J. F. Duncan.

Investigations on Bitter Pit in Apples. *Cawthron Inst. annu. Rep. 1959–60*. pp. 25–6. 1960. E. Chittenden.

The Effect of Fertiliser Application on the *Phytophthora* Disease of Hops. Ibid. pp. 32–3. 1960. T. B. C. Christie.

The Distribution of Polyphenol Oxidase in the Tomato Plant. Ibid. pp. 27–9. 1960. E. B. Kidson.

Alkaloids and Smoking Quality of Tobacco. Ibid. pp. 34–5. 1960. R. J. Monk.

Further Experiments on the Treatment of Tomato Seedlings with n-m-Tolyl-phthalamic Acid. Ibid. pp. 30–1. 1960. D. J. Stanton.

MASSEY AGRICULTURAL COLLEGE

Principal: Dr A. Stewart

PROJECTS

Agricultural Biochemistry—Evolution of improvements in milk analysis; vitamin B metabolism in ruminants; effect of variation in food intake and factors affecting food consumption on yield and composition of milk; phospholipids in buttermilk powder and in bovine muscle; interaction between amino compounds and sugars.

Agricultural Zoology—Epidemiology of roundworm parasitism in sheep; distribution of bumble bee species in South Island.

Dairy Husbandry—Investigation of hormonal control of mammary development; investigation of Hooker Forbes method for estimating Progestin; investigation of effects on animals of materials produced in pasture species (in cooperation with Plant Chemistry Division); nutritive value of whey for fattening pigs; studies of variation in food intake, of some of the factors affecting food consumption and of effects of variation in food intake on behaviour and performance of dairy stock.

Sheep Husbandry—Sheep breeding experiment; genetics of N-type and horns; carcass quality and meat investigation.

Soils and Field Husbandry—Pasture manuring under rotational grazing; fate of fertiliser phosphate in Tokomaru silt loam; tile drainage investigation into the extent of silting of tile drains resulting from: (a) different spacings between the end of tiles; (b) different types of cover over tiles with and without different spacings; (c) laying tiles in contrasting types of soil.

Veterinary—Leptospiral vaccine development.

PUBLICATIONS

Attrition of incisors of grazing sheep. *Nature, Lond. 185*:179. 1960. C. R. Barnicoat and D. M. Hall.

The grading of New Zealand lamb and mutton carcasses. *Proc. 13th annu. reciprocal meat Conf.*, Chicago. 1960. R. A. Barton.

New Zealand lamb and mutton research. Ibid. R. A. Barton.

A labour-saving device—the use of harness and crayon on rams to mark ewes during the tupping season. *Sheepfmg. Annu.* 1960. 211–6. T. S. Ch'ang.

The component fatty acids of *Sporidesmium bakeri* lipids. *Biochem. J. 75*:274–8. 1960. L. Hartman, J. C. Hawke, I. M. Morice, and F. B. Shorland.

A note on the mechanism of the conversion of carotene to vitamin A in the animal body. *N.Z. J. agric. Res. 3*:276–8. 1960. W. A. McGillivray.

Chemical changes in dried skim milk during storage. *J. dairy Res. 27*: 59–66. 1960. E. L. Richards and M. R. Chandrasekhara.

The seasonal availability to sheep of infective nematode larvae on pasture. *J. Helminth. 33*:281–8. 1960. J. H. Tetley.

The availability of the infective stages of nematode parasites to sheep in early spring. Ibid. *33*:289–92. 1960. J. H. Tetley.

The extent to which self-augmentation of nematode parasitism occurs in lambs. Ibid. *33*:293–300. 1960. J. H. Tetley.

The development of *Haemonchus contortus* in weaned and unweaned lambs. Ibid. *33*:301–04. 1960. J. H. Tetley.

UNIVERSITY OF AUCKLAND

Seagrove Radio Research Station

Director: Dr H. A. Whale

The station carries out research into the propagation of radio waves and the structures of the ionosphere. This work is based mainly on measurements of the bearing and elevation angles of signals received both from transmitters on the ground and from artificial satellites.

PROJECTS

An automatic bearing and elevation angle recorder is operated at Invercargill to study the effects of the auroral region on long-distance radio communications. Measurements made on B.B.C. signals show large variations in the preferred path for transmissions from England to Invercargill. A study of the effect of changes in the bearing of the transmitting aerial has also been carried out.

A new 120-ft rotating interferometer has been constructed at Auckland for simultaneous recording of the bearing, elevation angle, and amplitude of the signals received from up to six different stations with frequencies between 5 and 25 Mc/s. This instrument will be used for a long-term study of the diurnal and seasonal variations in the direction of arrival of signals from different distances, with particular emphasis on antipodal propagation.

A smaller 60-ft interferometer is used to record the bearing and elevation angles of signals received from artificial satellites. The records are used to determine the electron density at different heights in the ionosphere, and to determine the size and extent of irregularities and horizontal gradients of ionisation. A method has been evolved for accurately determining the electron density at the height of the satellite. The fluctuations in the amplitude of the received signals are also recorded, giving further information on the shape of the ionosphere.

Records are also being made of the amplitude and direction of arrival of pulses received from a 17 Mc/s back-scatter transmitter located at Slough.

A fixed array of 100 aerials, covering an area of 100 yards square, is used to study the fading of radio waves and for an investigation of diversity reception.

UNIVERSITY OF CANTERBURY

Industrial Development Department

Director: Mr T. R. Pollard

During 1960 the Director was requested by the Singapore Government to visit Singapore and advise on the need for an industrial research organisation and the type which should be established there.

As a result of his recommendations following investigation of the situation, the Singapore Government is establishing an industrial research unit on almost identical lines to our Industrial Development Department, and has requested that the Director and some of his staff again visit Singapore to establish the unit. This Department will also be called on to manufacture a considerable amount of test equipment.

The number of industrial projects handled for industry and government departments increased from 800 in 1959 to 860 this year, while money recovered totalled £13,885 compared with £13,000 in 1959.

PROJECTS

Performance of Rewirable Domestic Fuses—The major project completed in 1960 was an investigation into the performance of the rewirable domestic fuse. With the increasing load demands in the cities, substations are becoming more frequent, street mains have increased in size, and this means the prospective short-circuit currents are steadily increasing in value and thus the fuse is called upon to clear these higher currents. The project was carried out for the New Zealand Electricity Department and was a cooperative effort between this Department and Test Department of the N.Z.E.D. at Addington. Special testing apparatus was designed and some hundreds of different types of fuse have been tested. Information from the tests has been made available to the fuse manufacturers in New Zealand and they are modifying their fuse design to cope with the higher currents. The results of these tests will almost certainly bring about a New Zealand Standard for this type of fuse.

Other Projects—Aphid counter made for Division of Entomology, C.S.I.R.O., Canberra, similar to that made for and successfully used by Entomology Division, D.S.I.R.; further investigations of low frequency vibration of the synchronous machines of New Zealand Electricity Department; corrosion problems on the Lyttelton-Diamond Harbour pipeline and the Christchurch gasometer; series of brake horsepower tests on about 60 motorcars to determine effects of high octane rating of petrol; making of scientific appartus for use by Education Department for physics teaching.

Rolleston Radio Field Station

Officer in Charge: Dr C. D. Ellyett

PROJECTS

Meteor Rates in the Southern Hemisphere—During 1960 the main work – assisted also by USAF contract – has been the measurement of all-sky hourly meteor rates in the Southern Hemisphere. Great emphasis was placed on maintaining constancy of equipment. Almost complete coverage was obtained for the year 1 February 1960 to 31 January 1961. The results, at rates between 1600 and 2600 meteors per day, show an annual variation which is the minor image of the Northern Hemisphere. The effect is due to the tilt of the earth's axis, and proves that at the frequency of 69·5 Mc/s the ionosphere in no way affects the meteor rate. The results should be basic to other studies.

High meteor shower activity peculiar to the Southern Hemisphere has now been found in early December, over a number of years.

Other Projects—During the year a photometer recording upper atmosphere sodium, an infrared detector observing the upper atmosphere, an auroral spectrograph, an absorption and radio noise measuring instrument at 42 Mc/s and a detector of micropulsations of the earth's magnetic field were all in use.

PUBLICATIONS

Noise Suppression in Pulse Receivers. *Aust. J. Phys. 13*:750. 1960. E. McLauchlan.
Multiple Parameter Presentation of Radiar Meteor Echoes. *Inst. rad. Engngr. prof. Group Ant. Prop. Trans. AP. 9*:221. 1961. C. Ellyett and A. Stanbury.

COMMONWEALTH AGRICULTURAL BUREAUX

This Department, on behalf of New Zealand, is associated with the work of the Commonwealth Agricultural Bureaux (C.A.B.).

The organisation is one of the earliest established and one of the most successful on a Commonwealth-wide basis in the field of science. Commonwealth Governments contribute financially to the support of this organisation and the world-wide sale of its publications augments its funds.

The principal functions of the C.A.B. are the preparation and publication of abstracts and monographs based on the world's scientific literature in the fields of agriculture, animal research, and forestry. These and the other services of the organisation enable research and extension workers to keep up to date with the very extensive literature and the rapid developments in these subjects. The organisation consists of 10 bureaux, three institutes, and a headquarters, all but one of which are located in the United Kingdom.

New Zealand is represented on the Executive Council of the C.A.B. by the Department's Senior Scientific Liaison Officer in London. In New Zealand the C.A.B. is represented by a Liaison Officer, who is on this Department's Head Office staff, while each bureau or institute has an Official Correspondent who is a specialist in the subject concerned.

The five-yearly review conference, attended by administrative heads of agricultural research throughout the Commonwealth was held in London in September 1960. It provided opportunity for a critical examination and review of the general policy, activities, organisation, and financing of the C.A.B.

APPENDIX

THIRD ANNUAL REPORT OF THE ROSS DEPENDENCY RESEARCH COMMITTEE

The Hon. BLAIR TENNENT, Minister in Charge of the Department of Scientific and Industrial Research.

I HAVE the honour to submit herewith the third annual report of the Ross Dependency Research Committee for the year ended 31 March 1961.

INTRODUCTION

Although the Geological and Topographic Survey Programme was without aircraft, due to the loss of the Beaver aeroplane in 1959–60, generous air support from the United States Naval Support Force Antarctica enabled significant progress to be made in the surveys of the Ross Dependency. The Scott Base and Hallett Station scientific programmes, oceanographic surveys, and biological investigations continued at approximately the same level as during the previous year.

Scott Base

As before, the scientific programme comprised observation and research in aurora, ionosphere, geomagnetism, meteorology, radio propagation, and seismology. The Auroral Radar Station, which was installed at Arrival Heights on the Hut Point Peninsular during the summer of 1959–60, was not fully operational during the winter owing to technical difficulties. These have now been rectified and the station should provide valuable research data during the coming year.

In all other scientific disciplines the programme of observations was successfully carried out and substantial data were contributed for research study in New Zealand and overseas.

The survey expeditions require husky dog teams for their support. To maintain the dog population at Scott Base and to introduce new stock of the required age and stamina, 12 dogs were obtained from Greenland and flown by United States aircraft via America and the Pacific to Antarctica. These dogs were used very successfully in the field during last summer.

Although no major building alterations could be undertaken, minor alterations were carried out and the garage was reconstructed and floored with railway sleepers. An RNZAF Flight of five men completed the fitting out of the hangar with workshop and storage space, whilst the Auster aircraft and stores were assembled and returned to New Zealand.

Once again, unfortunately for the last time, HMNZS *Endeavour* took a major part in the resupply of the Base and some part in the transfer of personnel between New Zealand and McMurdo Sound, as well as making possible a series of oceanographic surveys.

Hallett Station

During the year under review, New Zealand provided the Station Scientific Leader and two other men for the maintenance of the scientific programme at this joint United States/New Zealand station. In November 1960, they were relieved by three other New Zealanders who will spend the ensuing year at the station.

The activities for which the New Zealand members of the joint team were responsible again comprised research in ionosphere, aurora, geomagnetism, and seismology.

GEOLOGICAL AND SURVEY EXPEDITION

Due to the loss of a sno-cat and a Beaver aircraft in the 1959–60 season, the programme for the current year had to be modified. The area selected was the coastal part of Southern Victoria Land between Byrd Glacier and Barne Inlet (80° 30′ S, 158–161° E) in the north and Nimrod Glacier and Shackleton Inlet (82° 30′ S, 161–163° E) in the south. The reconnaissance geology and surveying of this area of 6,000 square miles was completed by two four-man parties using dog teams with the assistance of the United States Naval Support Force which provided the air support.

VICTORIA UNIVERSITY OF WELLINGTON EXPEDITION

In continuation of work carried out by Victoria University of Wellington parties in 1957–58, 1958–59, and 1959–60, a university expedition of five men, including a Research Fellow from the University of Washington, U.S.A., investigated the series of valleys and ridges in the south-west of McMurdo Sound which may be described as "the Koettlitz area". They were flown in and out by United States helicopters, but otherwise back-packed their equipment from camp to camp during the period 1 December to 30 January in which they were in the field.

The geology and glaciology of the area were investigated, gravemetric traverses completed and meteorological readings taken.

HUTS RESTORATION PROJECT

Seven men, including three members of the New Zealand Antarctic Society working without remuneration, spent varying periods between 5 December and 29 January at Cape Royds and Cape Evans, Ross Island, restoring the old huts of Shackleton and Scott as nearly as possible to the appearance they had when occupied by the early expeditions. At Cape Royds this entailed clearing up the accumulation of rubbish in and around the hut and the stockpiling of foodstuffs and other stores not required to give the hut the desired "lived in" appearance. At Cape Evans, where the hut was almost full of ice and compacted snow, restoration involved digging out 250 cubic yards of ice and retrieving from it innumerable articles of clothing, etc., which had been ice bound for nearly 50 years. A number of interesting and historic documents were discovered and returned to New Zealand; the most valuable have been accepted by the Scott Polar Research Institute. Both huts were made tidy and thoroughly weatherproof, and are unlikely to be again filled with snow.

BIOLOGICAL STUDIES

Two men, including a biologist who had wintered at Cape Hallett in 1959, spent three weeks in January 1961, studying the Adelie Penguin population at Cape Adare, estimated at over half a million birds. They also spent a short period—17 to 29 October—at Cape Royds, and two periods amounting to more than three months at Cape Hallett continuing studies commenced in previous seasons on populations and breeding cycles of Skua Gulls and Penguins. At Hallett Station, the New Zealand scientists worked in close collaboration with their United States colleagues.

OCEANOGRAPHIC SURVEYS

A party of five made a three-month investigation of the currents and hydrology, and of the ice cover and ice movements in McMurdo Sound. Measurement of the flux and nature of water passing through the sound was made at hydro-holes dug through the sea ice, 8 to 11 ft thick, to the west and south of Cape Armitage.

Following the shore based work in McMurdo Sound, a party of base oceanographers sailed on *Endeavour* to carry out hydrological stations in McMurdo Sound and the western Ross Sea from 16 to 26 January and from 30 January to 8 February. From 23 February to 11 March, two New Zealand oceanographers joined USS *Edisto* to carry out, with United States oceanographers, Hydrological Surveys in the north-western part of the Ross Sea and approaches to Cape Hallett.

During *Endeavour*'s passage to Antarctica, a party of three oceanographers carried out hydrological measurements and occupied two biological stations between Campbell Island and McMurdo Sound. Throughout *Endeavour's* outward passage to Antarctica and during one cruise in the Ross Sea a proton magnetometer was towed by the ship to record the earth's magnetic field. By courtesy of the United States Naval Support Force a New Zealand oceanographer worked aboard USS *Wilhoite,* the search and rescue ship, during two of her periods on station midway between New Zealand and Antarctica. Extensive hydrological observations and some biological work was accomplished in the vicinity and southwards of Campbell, Auckland, and Macquarie Islands.

PARTICIPATING ORGANISATIONS

It is the responsibility of Antarctic Division, D.S.I.R., to implement the approved scientific programme formulated by the Ross Dependency Research Committee. However, scientific responsibility for various sections of the programme, provision of scientific equipment and working up and publication of results rests as follows:

Scott Base and Hallett Station Programmes:

Geophysics Division, D.S.I.R., Dominion Physical Laboratory, D.S.I.R., New Zealand Meteorological Service, Air Department.

Geological and Survey Programme:

Geological Survey D.S.I.R., Lands and Survey Department.

Biological Investigations:

Dominion Museum.

Oceanographic Surveys:

New Zealand Oceanographic Institute, D.S.I.R.

INTERNATIONAL RELATIONS

The Committee notes with pleasure that the strong international cooperation developed during and since the International Geophysical Year continues unabated. Not only is there a steady exchange of scientific data and results between Antarctic countries, but the Special Committee for Antarctic Research (S.C.A.R.) of the International Council of Scientific Unions continues to exert a strong influence in the formulation of coordinated programmes for Antarctic research. S.C.A.R. held its fourth meeting at Cambridge, England, from 29 August to 2 September 1960. New Zealand was represented by Mr R. W. Willett, Director, Geological Survey, D.S.I.R., assisted by four advisers. All these gentlemen were in the United Kingdom on other business and hence attended at minimal cost to the New Zealand Government. The meeting was marked by active discussion on all phases of Antarctic research and produced substantial recommendations on future Antarctic studies. With the Government's concurrence the Royal Society of New Zealand, as the adhering body to S.C.A.R., invited the Committee to meet in New Zealand during 1961. This meeting will be held in Wellington from 9 to 14 October.

ACKNOWLEDGMENTS

The Ross Dependency Research Committee again acknowledges with grateful thanks the assistance given by many agencies towards the implementation of the New Zealand Antarctic Programme. Of particular note is the unfailing support at all times of the United States Naval Support Force Antarctica. As HMNZS *Endeavour* is now to be withdrawn from Antarctic service, the Committee wishes to pay a special tribute to the New Zealand Naval Board and to all officers and men of *Endeavour*. Their cooperation and assistance has enabled Scott Base to be resupplied and maintained since its establishment five years ago.

E. I. ROBERTSON, Vice-Chairman,
Ross Dependency Research Committee.

PUBLICATIONS LIST

General

New Zealand I.G.Y. Antarctic Expeditions, Scott Base and Hallett Station. *N.Z. Dept. sci. indus. Res. Bull.* 140. 1961. T. Hatherton.

Some Operational and Mechanical Aspects of the 1959–60 Victoria Land Traverse. I.G.C. Antarctic Glaciological Data Field Work. 1959–60. Rep. 968/3. 1960. A. J. Heine.

Upper Atmosphere Physics

Geometry of the Southern Auroral Zone and the Evidence for the Existence of an Inner Zone. *Nature, Lond. 186*:288–90. 1960. T. Hatherton.

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Relationship Between Red Auroral Arcs and Ionospheric Recombination. *J. Res. nat. Bur. Stand. Sec. D. 65*:129–35. 1961. G. A. M. King and F. E. Roach.

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Geophysics, Seismology, and Geomagnetism

Electrical Resistivity of Frozen Earth. *J. geophys. Res. 65*:3023–4. 1960. T. Hatherton.

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Microseisms at Scott Base. *Ibid. 3*:381–405. 1960. T. Hatherton.

A Note on the Amplitude-Period Relationship of Earth Noise in the 1–8 Second Range. *Bull. seis. Soc. Amer. 51*:13–16. 1961. T. Hatherton.

Gravity Observations in the Wright Valley Area, Victoria Land, Antarctica. *N.Z. J. Geol. Geophys. 3*:543. 1960. C. Bull.

The Palaeomagnetism of Some Hypabyssal Intrusive Rocks from South Victoria Land, Antarctica. *Geophys. J. R.A.S. 3*:211. 1960. C. Bull and E. Irving.

Geology

Lower Tertiary Micro-fossils from McMurdo Sound, Antarctica. *Nature, Lond. 186*:700–02. 1960. L. M. Cranwell, H. J. Harrington and I. G. Speden.

Geological Reconnaissance in Victoria Land, Antarctica. *Ibid. 189*:545. 1961. B. C. McKelvey and P. N. Webb.

Recent Moraines of a Lobe of the Taylor Glacier, Victoria Land, Antarctica. *J. Glaciol. 3*:652–3. 1960. H. J. Harrington and I. G. Speden.

Post Glacial Terraces Near Cape Chocolate, McMurdo Sound, Antarctica. *N.Z. J. Geol. Geophys. 3*:203. 1960.

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